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* SELECTED LIST OF PUBLICATIONS WITH ABSTRACTS *
WESTERN REGIONAL RESEARCH LABORATORY, ALBANY 6, CALIFORNIA
Bureau of Agricultural and Industrial Chemistry
Agricultural Research Administration
U. S. Department of Agriculture

The mimeographed materials are available on request. A limited number of bulletins and reprints of some of the Journal articles are also available. Those not available are marked with an asterisk (*). Those listed for the first time are preceded by the symbol (#).

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FREEZING PRESERVATION OF FOODS

Mimeographed information on frozen foods:

- 10 Frozen pork and beans of the tomato sauce type. June, 1943.
- 34 A test for adequacy of blanching in frozen vegetables. Nov., 1943.
- 35 Determination of ascorbic acid in fresh, frozen, and dehydrated foods. Dec., 1943.
- 36 Freezing preservation of pumpkin pie stock. Dec., 1943.
- 40 Velva Fruit--A new frozen fruit dessert. Rev. No. 1. March, 1946.
- X 46 Selected bibliography on freezing preservation of fruits and vegetables, 1920-45. Rev. No. 2. February, 1946.
- 57 Commercial preparation and freezing preservation of sliced apples. Aug., 1945.
- 66 Factors that affect quality in the freezing preservation of peas. June, 1944.
- *120 Sanitation of frozen foods. June, 1946.

Bulletins on frozen foods:

- Bedford, Berry, Boggs, Campbell, Cunha, McGregor, Overholser, Pool, Sorber, Straka, and Watts. Locker and home freezing of farm products. Wash. Agr. Expt. Sta. Pop. Bul. 180. June, 1945.
- Diehl and Warner. Freezing to preserve home-grown foods. U. S. Dept. Agr. Circ. No. 703. Aug., 1945.
- Home freezing of fruits and vegetables. U. S. Dept. Agr. AIS-48. May, 1946.
- Making Velva Fruit at home. U. S. Dept. Agr. AIS-22. May, 1945.

Journal articles on frozen foods:

GENERAL:

- *H. Campbell. Some fundamentals of vegetable preservation by freezing. *West. Frozen Foods* 6(8):3-5. June, 1945.
This paper emphasizes the necessity for high and uniform levels of quality if the progress made in vegetable preservation by freezing is to be maintained. The author discusses the raw materials from the standpoint of variety, source, maturity, and handling. Under processing methods he treats blanching, cooling, and the freezing procedure. Storage practices are briefly discussed with reference to temperature and stacking. The hazards are pointed out and means of avoidance are provided.
- *H. C. Diehl. Can frozen foods help win the war and write the Peace? *West. Frozen Foods* 3(4):5-6, 8, 10. 1942.
An analysis of the part that frozen foods might play in the war and the strategic advantages of frozen foods, particularly their saving of packaging materials such as tin, are discussed in this paper.
- *H. C. Diehl. Technological aspects of locker plant industries. *Quick Frozen Foods*: I. 3(7):16-17. 1941; II. 3(8):24, 37-38. 1941.
In this article the author emphasizes the importance of the locker plant in food conservation, its increasing use, and its relationship to the frozen foods industry, the necessity for uniform zero Fahrenheit or slightly lower temperature, the significance to the industry of sharp freezing facilities and plant improvement, the desirability of dispensing information to locker patrons regarding the preparation of raw materials and the use of frozen materials, the value of uniform practice in the locker industry, and the need for a uniform, clearly objectified policy for the industry as a whole.

- *V. D. Greaves and M. M. Boggs. Trends in freezing preservation of foods. *Jour. Hom. Econ.* 37(1):23-26. Jan., 1945 (With Univ. Calif.)
This paper analyzes trends that were manifest shortly before the close of the war and treats of blanching, thawing, nutritive values, and new products including prefrozen foods.

- L. B. Howard and H. Campbell. Dehydrofreezing--new way of preserving food. *Food Indus.* 18(5):674-676. May, 1946.

Experiments with several fruits and vegetables have shown that moderate dehydration (removal of about two-thirds of the water content) followed by freezing storage resulted in excellent products in most cases. Advantages of this new method, tentatively called dehydrofreezing, are savings in weight, space, packaging materials, and refrigeration load. The preliminary experiments have dealt with potatoes, peas, carrots, asparagus, cherries, boysenberries, and apricots.

- *D. G. Sorber. An analysis of the frozen fruit industry in Utah. *Farm and Home Science* 51(2):1, 8-10. June, 1944.

This paper presents the economic background of the frozen-food industry; some significant trends to the date of writing (1944), and an analysis of the industry in Utah. The fruits treated are apples, apricots, sweet cherries, pears, plums, prunes, blackberries, gooseberries, raspberries, and strawberries. The prices paid for these fruits are briefly discussed in terms of average prices (1927-1942) and medium prices.

- *D. G. Sorber. Frozen fruits available. *Ice Cream Field Year Book*. 1942.

This paper presents material on the availability of frozen fruits and their suitability for use in ice creams and sherbets.

SANITATION

- *J. A. Berry. Preserving fruits and vegetables in frozen food lockers. *West. Canner and Packer* 34(4):50-52. 1942.

This paper deals with the selection, preparation, and freezing of the chief fruits and vegetables suitable for preservation in cold storage lockers.

- *J. A. Berry. The fewer the bacteria, the better the frozen pack. *Canner* 94(4):13-14. 1941.

This paper describes food spoilage as produced by bacteria and other micro-organisms, the sources of contamination, the significance of bacterial counts, and kindred topics.

- *J. A. Berry. Frozen foods have good health record. *Quick Frozen Foods* 6(3):46. 1943.

This is a semitechnical article, pointing out that frozen foods have not been nor are likely to be responsible for any outbreak of food poisoning.

- *E. R. Wolford. Direct microscopic method to estimate sanitary history of frozen pack peas. *West. Canner and Packer* 35(13):58. Dec., 1943.

This paper enumerates the advantages of direct test over plate-count or cultural method for frozen food products.

QUALITY CONTROL

Fruits and Vegetables in General:

- *H. J. Loeffler and J. D. Ponting. Ascorbic acid. Rapid determination in fresh, frozen, or dehydrated fruits and vegetables. *Indus. and Engin. Chem., Analyt. Ed.* 14(11):516-549. Nov., 1942.

This paper reports that ascorbic acid can be determined quickly in fruits and vegetables, whether fresh, frozen, or dehydrated, by disintegrating the sample

with dilute metaphosphoric acid in a high-speed cutter and measuring the decolorizing effect of the extracted ascorbic acid on indophenol dye with a photo-electric colorimeter. The ascorbic acid is distributed within the total liquid phase present, which includes the water and dissolved solids originally in the sample. Hence by using a large proportion of extractant and knowing the approximate amount of liquid in the sample, the ascorbic acid can be determined from as little as 3 ml. of filtrate after only one extraction. By using a large amount of 1-percent metaphosphoric acid as the extractant the buffering step is avoided, since the pH obtained is sufficiently low to prevent losses during blending, yet sufficiently high to prevent fading of the dye reagent. The rate of fading is high with many previously recommended extraction mixtures. Rapid ascorbic acid determinations can be made easily on highly pigmented berries and tough dehydrated vegetables.

- E. R. Wolford and A. A. Andersen. Propionates control microbial growth in fruits, vegetables. *Food Indus.* 17(6):622-624, 726, 728, 730, 732, 734. June, 1945. Interest in chemical compounds that check microbial growth has led to the use of several preservatives in food products and also to research on their mode of action and their effect on foods. This paper presents data to show that propionate treatment of figs and berries appreciably retards development of mold. Treatment of shelled peas and lima beans maintains quality longer during delay between harvesting and processing. The effect varies with pH.

Fruits in General:

- *H. J. Loeffler. Retention of ascorbic acid in strawberries during processing, frozen storage, and manufacture of Velva Fruit. *Food Res.* 11(1):69-83. Jan.-Feb. 1946.

This paper presents data of use in the manufacture of Velva Fruit. The effects of the condition of the fruit, of freezing, of freezing and short storage, of extended storage, and of defrosting were studied in relation to the retention of ascorbic acid in sugared and unsugared puree.

- J. D. Ponting. Catechol test for frozen fruits. *Quick Frozen Foods* 7(5):31, 46, Dec., 1944.

Darkening of fruits has long been a source of annoyance to many frozen fruit packers. Fruits that discolor readily, such as apples, apricots, and peaches, require pretreatment with a scald, sulfur dioxide or other treatment, before they are frozen, as a means of inactivating the enzymes that cause discoloration. Reduction of enzyme activity controls darkening of the fruit flesh before freezing, during frozen storage, and after the fruit is defrosted. The catechol test as developed in this Laboratory is generally applicable in determining the effectiveness of scalding treatments (with steam or hot water), since in this case the enzyme usually must be completely inactivated before the fruit is frozen to prevent browning when it is defrosted. The test is also useful in comparing the effectiveness of various treatments for the inactivation of oxidizing enzymes in fruits. Use of this test has shown that scalding and treating with SO_2 are the most effective of many treatments tested in this Laboratory.

- J. D. Ponting and G. Johnson. Determination of sulfur dioxide in fruits. *Indus. and Engin. Chem., Analyt. Ed.* 17(11):682-686. Nov., 1945.

Sulfur dioxide is commonly used to preserve color and flavor of dried fruits and certain frozen fruits. Its use requires control within rather wide limits in dried fruits but within relatively narrow limits in frozen fruits. As a result of the recent large expansion of the frozen-fruit industry- the problem of controlling sulfur dioxide concentration in frozen fruits has become of particular

interest. The sulfur dioxide content of frozen fruits and of other types of fruit can be determined rapidly by (1) extraction, (2) blending in buffered sodium chloride solution, which stabilizes sulfur dioxide against enzymic and autoxidation, (3) filtration, (4) treatment with alkali to dissociate combined sulfur dioxide, and (5) acidification and titration with iodine, with and without added formaldehyde, which binds sulfur dioxide.

- *W. Rabak and H. C. Diehl. "Fondant-like" formation on fruits caused by crystallization of sucrose. *West. Canner and Packer* 36(4):55. April, 1944.

The conclusions from this investigation were that the fondant-like formation so frequently encountered in commercially stored frozen "sugar-pack" fruits is due primarily to the crystallization of sucrose from the pack. The peculiar "mold-growth" appearance is in all probability due to the slow crystallization of the sucrose influenced by conditions not now clearly understood.

- *D. G. Sorber. Frozen, sliced, crushed, and pureed fruits. *Canner*: 1. 94(7):16-17, 36. 1942; 11. 94(8):18, 20, 22, 32. 1942.

Part I. Part I of this paper comprises a discussion of the basic factors involved in preserving in sliced, crushed, and pureed fruit the natural fresh-fruit flavor and color through the freezing process. Varietal characteristics, maturity at harvest, transportation, storage, and precooling are dealt with; the preparation of fruit, the contaminative effect of certain metals, and fundamentals of packaging are also presented.

Part II. The actual freezing operation is discussed in the second part of this paper, including methods of freezing, rate of freezing, storage temperature, and defrosting. The paper concludes with a discussion of the chief uses of frozen fruits prepared in the various forms specified by the title of the paper.

Vegetables in General:

- M. P. Masure and H. Campbell. Rapid estimation of peroxidase in vegetable extracts, an index of blanching adequacy for frozen vegetables. *Fruit Prod. Jour. and Amer. Food Mfr.* 23(12):369-374. Aug. 1944.

A simple and rapid colorimetric method for the quantitative estimation of peroxidase activity in vegetable extracts is presented. Values obtained by the method show correlation with degree of blanch in stored vegetables preserved by freezing. The quantitative method has been modified to provide a simpler, semiquantitative test for plant use. Since it is sufficiently accurate to give good correlation with quality retention in a number of frozen vegetables, it may be used to determine adequacy of blanch.

- *J. P. Nielsen. Rapid determination of starch in vegetables. *Indus. and Engin. Chem., Analyt. Ed.* 15(3):176-179. March, 1943.

In certain vegetables such as peas, corn, and lima beans, the starch content of the seed tends to increase as the plant matures. This increase in starch is usually associated with a decrease in total sugar, tenderness, and general food quality of the vegetables. A very rapid and reasonably accurate method for the determination of starch in certain vegetables has been developed. It includes grinding the fresh sample in a Waring Blendor-type disintegrator, extracting the starch with 4.0 to 4.8 molal perchloric acid, and estimating by photoelectric colorimeter the dissolved starch indicated by the blue color produced with iodine. Alcohol extraction of the products studied was found to be unnecessary. The use of a red filter in the colorimeter considerably reduces the error produced by dextrans when present.

- *J. P. Nielsen and P. C. Gleason. Rapid determination of starch. Factors for starches and comparison with acid and enzymic hydrolysis methods. *Indus. and Engin. Chem., Analyt. Ed.* 17(3):131-134. March, 1945.

This paper presents factors for the calculation of starch in various vegetables with potato starch as a standard, compares results by the proposed method with those by an enzyme procedure, describes minor revisions that increase the accuracy of the original method, and describes the application to dehydrated foods. Data are presented to show that the enzyme procedure used for comparison is not applicable to all types of starches.

- *J. P. Nielsen, H. Campbell, and M. Boggs. Tenderizing vegetables for freezing. *West. Canner and Packer* 35(6):49. June, 1943.

Experiments reported in this paper show blanching in solution of sodium hexa metaphosphate to be an effective method of tenderizing.

- J. P. Nielsen and G. S. Bohart. Determination of crude lipid in vegetable matter. *Indus. and Engin. Chem.* 16(11):701-703. Nov., 1944.

Measurement of maturity in vegetables is of importance to the grower, processor, and consumer. Maturity at harvest may affect yield of raw product, processing behavior, and quality and yield of final product. Many vegetables store starch, which can be measured as an index of maturity. Soybeans, however, do not store starch, and sweet corn presents analytical difficulties due to its glycogen content. These and other vegetables increase in lipid content as they mature and a simple method for the determination of crude lipid might serve as an index of maturity. This paper presents such a method. The complete procedure including preparation of the sample can be carried out in a relatively short time. The method yields considerably larger quantities of crude lipid from certain types of vegetable material such as immature seeds than do the commonly accepted procedures for crude fat. It is equally well adapted to wet or dry ground products.

Specific Vegetables:

Beans:

- *D. G. Sorber. Freezing baked beans and other prepared foods. *Quick Frozen Foods* 5(8):18-19, 24. 1943.

This paper is a report of work done in the freezing of baked beans. Aspects of preparation, evaluations of color and flavor, nutritional value, and storage behavior are discussed.

Corn:

- *H. Campbell. Scalding of cut corn for freezing. *West. Canner and Packer* 32(9):51-53. Aug., 1940.

The primary purpose underlying the scalding of corn is, of course, to inactivate the enzymes present in the product which otherwise would bring about the development of off flavors, odors, and colors during the storage period. Because little seemed to be known relative to minimum scalding requirements for cut corn, some experiments were undertaken to determine this point.

Peas:

- M. M. Boggs, H. Campbell, and C. D. Schwartze. Factors influencing the texture of peas preserved by freezing. *Food Res.*: *1. 7(4):272-287. July-Aug., 1942. 11. 8(6):502-515. Nov.-Dec., 1943. (With Wash. Agr. Expt. Sta.)

With the rapid growth of the pea-freezing industry, there has been need for more information regarding the variations in texture of frozen peas and the causes of such variations in order to eliminate or control, if possible, those

factors which contribute to toughness or lack of uniformity in the pack. The specific texture investigations reported in this paper are as follows: (1) the amount of variation for a given sieve size and variety of peas grown in the same field and harvested on the same day; (2) variation for a given sieve size and variety of peas grown in the same field but harvested on different days of the same season; (3) effect of cooking for 5, 10, and 15 minutes; (4) effect of vining; and (5) effect of delay between vining and freezing.

Part II: Varieties of peas suitable for freezing were grown under ordinary commercial conditions, vined, cleaned, scalded for one minute in water at 98.9° C. (210° F.), cooled in water to approximately 14° C. (57.2° F.), packaged in 12-ounce waxed-paper cartons, wrapped, and heat-sealed in moisture-vapor-proof cellophane, then frozen and stored at 0° F. After several months of storage the frozen peas were cooked without preliminary thawing in boiling water for six minutes, and the texture of the skins of all samples was determined by measuring the load in kilograms required to penetrate three layers of skins with a one-eighth-inch steel, ball-bearing penetration point. In one study the texture of the cotyledon was also determined by measuring the load required to crush one cotyledon to one-fourth of its thickness. Special handling procedures were required in order to investigate a particular treatment. Results as briefly summarized in this paper were: (1) brine separation is not a practical means of separating peas into skin-texture groups, (2) the cotyledons of frozen peas were tougher than those of fresh peas but there was no difference in skin texture, (3) fresh peas delayed for selected periods after harvest showed less toughening of skin texture in comparison with delayed frozen peas of larger sizes, about the same degree of toughening for the smaller, (4) thawing for selected periods did not toughen the skins of frozen peas, but refreezing after thawing, storing for two weeks at -17.8° F. and then cooking without thawing seriously toughened the skin, (5) bruising alone appeared to have the effect of slight toughening but addition of vine and leaf juice to unbruised, hand-podded peas significantly toughened the skins of sizes 3, 4, 5, and 6.

H. Campbell. Notes on the tenderometer. *West. Canner and Packer* 31(6):113-114. May, 1939.

The rapid growth of the frozen pea industry, in evidence even before the war, showed the need for quality control and standardization. This paper indicates the usefulness of the tenderometer in grading peas intended for freezing.

*H. Campbell. Temperature and tenderometer. How temperature may affect tenderometer value for peas. *West. Canner and Packer* 34(2):39-40. Feb., 1942.

While the work reported in this paper was of a preliminary nature, it seems apparent that the temperature of peas may significantly affect their tenderometer values and is a factor which should be taken into consideration in the grading of raw peas with the tenderometer. The temperature effect points to the desirability of the development and adoption of standardized procedure for the taking of tenderometer readings wherein the samples would be brought to a uniform temperature by tempering in water. Variations in the degree of hardness of the tempering water need not be taken into consideration in the adoption of such a procedure.

H. Campbell. The splitting of shelled peas intended for freezing. *West. Canner and Packer* 32(18):49-50. July, 1940.

Presence of split and otherwise damaged peas materially detracts from the appearance of the frozen product, and, if severe, may constitute a grade defect in the application of the Tentative United States Standards for grades of frozen peas. Because the packer should know something of the factors responsible for this condition so that he may adopt preventative measures in the field or packing plant, this paper was prepared. Data contained herein show that the initial cause for excessive splitting of shelled peas intended for freezing seems to lie in improper viner operation. Inasmuch as an apparent increase in splitting takes place on the holding of peas in an iced or uniced condition, it would seem that speed in handling and avoidance of delays would tend to reduce the percent of damaged peas in any pack. Although scalding techniques may account for some splitting of peas, their significance seems to be relatively unimportant; the advantage seems to be with steam scalding and, where water scalding is employed, at temperatures below or at 200° F.

*H. Campbell and H. C. Diehl. Quality in frozen pack peas. *West. Canner and Packer* 32(10):48-50. Sept., 1940; 32(11):51-53. Oct., 1940.

Factors that influence quality-maturity, handling, variations within the pack, standards for grades-are discussed in this paper.

*J. P. Nielsen, E. R. Wolford, and H. Campbell. Delay affects frozen pea quality. *West. Canner and Packer* 35(6):47-48. June, 1943.

This evaluation of the losses in quality constituents in shelled peas delayed between harvesting and freezing shows that, when peas are held at an average temperature of 76° F., serious losses do not occur in four hours, but that beginning at eight hours there is a rapid deterioration in sugar, vitamin C, flavor, and texture, accompanied by great increases in bacterial content. Peas delayed twelve hours at 76° F. are unfit to pack, and even an eight-hour delay is to be avoided. The results are presented in order to indicate maximum limits for unavoidable delays. The use of ice or any other method of reducing temperature is to be strongly recommended during such delays and may be routinely necessary in many instances. A reduction in temperature of the raw product, if only to 50° F., as in the work described, is of considerable benefit, especially in checking growth of bacteria which with natural respiration of the product are, as is well known, responsible for loss of sugar and lack of fresh flavor.

*E. R. Wolford. Direct microscopic method to estimate sanitary history of frozen pack peas. *West. Canner and Packer* 35(13):58. Dec., 1943.

(See sanitation).

Tomatoes:

*Frozen tomatoes not too good, juice has possibilities. *Food Indus.* 16(8):632-633, Aug., 1944.

Frozen juice has good color and pleasant flavor, but tomato sections collapse on thawing. The general intention of this paper is to suggest means of improving processing frozen tomatoes and juice.

PACKAGING:

*H. C. Diehl and W. Rabak. Packaging of frozen foods under war conditions. *Proc. Inst. Food Technol.*, pp. 117-120. 1942.

Efficient packaging to guard against loss of moisture and oxidative changes in frozen foods and thus insure quality retention in storage was one of the war-time problems of the frozen food industry. Glazing is suggested as one important means of retaining quality.

- *W. Rabak. Are your cartons moisture-proof? *West. Canner and Packer* 33(11):52-55. Oct., 1941. This paper reports a series of experiments which indicate that wraps and liners, not package types, prevent weight loss and hence protect the color and quality of frozen peas.
- *W. Rabak. The protective packaging of frozen foods. *Refrig. Engin.* 48(5): Nov., 1944; *Good packaging* 6(2):21. Feb., 1945.
This paper is a discussion of the factors influencing moisture permeability, packaging materials and package types, packaging and quality retention, specialized packages, and a new method of packaging frozen foods.
- *W. Rabak and G. L. Dehority. Effects of heat sealing on water-vapor permeabilities of coated cellophanes. *Modern Packaging* 17(7):161-163, 220. Mar., 1944. This paper emphasizes the destructive effects of high temperatures upon coatings and their erratic behavior, possibly due to impairment. The efficiencies of these cellophanes were not impaired by a one-second contact between sealing jaws at 285° F. However, the permeability of the heat-modified areas was increased 3 to 8 times when the sealing surfaces were maintained at a temperature of 385° F. This indicates that the lowest sealing temperature commensurate with firm bonds is desirable. Because coatings vary in behavior during sealing, it is desirable to adjust temperatures to coating types. A sealing temperature of 450° F. was markedly destructive to the three cellophanes included in this study, in one case increasing the permeability of the heat-modified area 60 times over that of an equivalent area of the untreated sheet.
- W. Rabak and J. B. Stark. Impact--effect on moisture barriers at low temperature. *Modern Packaging* 18(8):137-139, 166. April, 1945.
This paper reports that commercial paraffin-base coatings were more nearly impervious to moisture vapor before subjection to impact tests than any of four commonly employed heat-sealing over-wrapping materials. Standardized impact test at 70° F. caused greater impairment of the sheet-material overwraps than of the dip-coatings. The efficiencies of both the overwraps and the commercial dip coatings (except coating D) were seriously impaired by impact tests at 0° F.
- *W. Rabak and J. B. Stark. Practical experiments demonstrate protective value of double wrap. *West. Canner and Packer* 38(11):74-75. Oct., 1946.
The experiments described in this paper demonstrate that the double over-wrap increases the barrier effect. This is particularly obvious in the instance of waxed paper, which resulted in a five-fold increase in water-vapor resistance. The efficiency of the cellophane overwrap was increased three-fold. Although this increase in barrier effect may be due in part to off-set points or areas of leakage, it is probable that the transference of coating from one sheet to another in the fluid state during heat sealing is also involved. The known facts regarding the destruction of coatings during heat-sealing imply that it is possible that the second over-wrapping operation results in a partial re-sealing of the porous areas of the first overwrap. The extensive areas of impaired coating shown by the starch-iodine method suggests the latter possibility.
- *W. Rabak and J. B. Stark. What is the protective value of the double over-wrap? *Food Indus.* 18(11):1680-1691, 1828. Nov., 1946. (See above).

W. Rabak and J. B. Stark. Sealing temperature and WVP--A correlation in effectiveness of waxed papers. *Modern Packaging* 19(8):157-160. April, 1946.

The heat-sealing operation definitely impairs the water-vapor resistance of waxed papers. Extent of impairment by heat increases with elevation of sealing temperature. A sealing temperature of 200° F. is less destructive to water-vapor resistance than sealing temperatures of 325 and 450° F. The latter temperature is excessively destructive. Tests show that machine-sealed overwraps of waxed paper are not as efficient in barrier effect as controlled hand-sealed overwraps which indicates the necessity for improvement of mechanical heat-sealing mechanisms. The starch-iodide impregnation method visually demonstrates the effect of varying sealing temperatures on the porosity of paraffin-coated papers.

DEHYDRATION OF FOODS

Mimeographed information on dehydration:

- 15 Bin-type finishing driers in vegetable dehydration. 1943. Revised July, 1944
- 31 Application of drying rate nomographs to the estimation of tunnel-dehydrator drying capacity.
 - I. Riced white potatoes. Nov., 1943.
 - II. Blanched sweet corn. Nov., 1943.
 - III. White potato strips--vertical air flow. Jan. 1944.
 - IV. Shredded cabbage. Feb., 1944.
 - V. Onion slices. April, 1944.
 - VI. Sweetpotato strips. Sept., 1944.
 - VII. White potato half cubes. March, 1945.
- 35 Determination of ascorbic acid in fresh, frozen, and dehydrated foods. Dec., 1943.
- 39 Cost accounting for vegetable dehydration plants. Jan., 1944.
- 47 The sampling and analysis of gases in cans of dehydrated vegetables. June, 1944.
- 58 New peroxidase test procedure for dehydrated potatoes to indicate adequacy of blanching. Aug., 1944.
- 75 Tray materials in relation to sulfited, dehydrated vegetables. March, 1945.

Dehydrator designs:

- Type A - Transverse-flow cabinet dehydrator.
- Type I - Steam-heated cabinet dehydrator (single-truck unit).
- Type J - Steam-heated cabinet dehydrator (double-truck unit).
- Type N - Vegetable dehydrator, tunnel type, two-stage.
- Type O - Cabinet dehydrator with cabinet blancher and bin finisher.
- Types P, Q - Counter flow tunnel dehydrators.
- Dwg. D-96 - Multibin finisher.
- Dwgs. C-112, 113 - Laboratory experimental cabinet drier.
- Dwg. C-115 - Steam heating arrangements for tunnel dehydrators.
- Dwg. A-118 - Friction stop for trucks.

Preparation-equipment designs:

- Dwg. D-108 - Tray-loading and de-traying table.
- Dwg. D-116 - Picking and trimming table.
- Dwg. D-214 - Draper-type atmospheric steam blancher.

Bulletins on dehydration:

- Preservation of fruits and vegetables by commercial dehydration. U. S. Dept. Agr. Circ. 619. 46 pages. Feb., 1942.

Commercial dehydration of vegetables and fruits in wartime. *U.S. Dept. Agr. Misc. Pub. 524*. 29 pages. Sept., 1943.

Vegetable and fruit dehydration. A manual for plant operators. *U. S. Dept. Agr. Misc. Pub. 524*. 218 pages. June, 1944.

Journal articles on dehydration:

General:

- E. M. Chace. Present status of dehydration in the United States. *Proc. Inst. Food Technol.* pp. 70-89. 1942.

In this paper a brief account is given of dehydration investigations initiated by the Chief of the Bureau of Agricultural and Industrial Chemistry at the beginning of World War II. Conditions and practices required for operating a drying plant are reviewed.

- R. M. Reeve. Facts of vegetable dehydration revealed by microscope. *Food Indus.* 1. (12):51-54, 107-108. Dec., 1942.

Fundamentally, the problem in vegetable dehydration is to remove water from the tissue, to retain the nutritive constituents in a sound and durable condition during storage, and to rehydrate the tissues when the vegetables are prepared as food. The physical changes and some of the chemical changes were studied microscopically. The microscopic observations show interesting correlations with some of the analytical data on vitamin retention, and help to explain some of the reasons for vitamin loss. The text of the paper emphasizes the need for proper dehydrating methods. Photomicrographs illustrate some of the tissue changes which are related to problems of vegetable dehydration.

- *W. B. Van Arsdel. Some engineering problems of the new vegetable dehydration industry. *Heating, Piping and Air Conditioning* 15(3):157-160. 1943.

Wartime conditions introduced a number of new dehydration systems for the drying of foods. Six essential specifications to be considered in the design of a dehydration system and complete new data on vegetable dehydration with charts showing the drying rates were provided in this paper for the use of prospective dehydration plant operators. Due to the war program emphasis was placed upon the design of equipment that required fewer man hours of skilled labor in fabricating the necessary equipment. Individuals doing work in this field were urged to make use of the comprehensive information available in the various Government and State bureaus.

- *W. B. Van Arsdel. Recent engineering investigations in food dehydration at the Western Regional Research Laboratory. *Proc. 4th. Ann. Meet. National Dehydrators Assoc.* pp. 33-35. 1945.

This paper is a brief report on certain phases of the engineering work on dehydration. Removal of moisture in the low ranges by means of tunnel dehydrators having proved rather ineffective, the use of finishing bins as a means of reducing moisture content is discussed. A brief description of the Laboratory's work in equipment development is provided, particular attention being given a new type of blancher and an improved onion peeler.

Plant and equipment:

- E. A. Beavens. Cabinet dehydrators suited to small-scale operations. *Food Indus.* 1. 16(1):70-72, 116. Jan., 1944; 11. 16(2):90-92, 134. Feb., 1944; 111. 16(3):75, 135-136. Mar., 1944.

These units are practicable for experimental work and for dehydrating from 1 to 20 tons of fresh vegetables a day. They also permit handling of different products at the same time. The author discusses the types of cabinets and their operation and uses in a comprehensive manner. Cabinet dehydrators have definite

advantages for certain operations. Single cabinets are practicable for experimental work. Multistage cabinet units, combination compartment-and-tunnel systems and duplex cabinet arrangements are used for commercial operations.

- W. D. Ramage and C. L. Rasmussen. This is what it costs to dehydrate vegetables. *Food Indus.*: I. Buildings, plant layout, capital investment. 15(7):64-71, 137, 138. July, 1943; IIA. Processing costs--labor, raw material. 15(8):66-67, 118, 119. Aug., 1943; IIB. Processing costs--summarized. 15(9):75-77, 126. Sept. 1943. In this paper, plant layout, capital investment, and operating costs are given for plants of 25 to 100 tons daily capacity. Good plant layouts are illustrated and operating practices discussed. Processing costs are discussed in detail in the second and third parts of the article.

- *W. B. Van Arsdel. Tunnel dehydrators and their use in vegetable dehydration. *Food Indus.*: I. 14(19):43-46, 106. 1942; II. 14(11):47-50, 103. 1942; III. 14(12):47, 50, 108-109. 1942.

Factors governing the choice of a dehydrator for vegetables and various available arrangements of tunnel dehydrators, are discussed in this article. The physical laws and engineering fundamentals of dehydrator operation, written to guide the plant operator, are given. The operating characteristics of tunnel dehydrators are discussed.

- *W. B. Van Arsdel. Tray and tunnel drying methods and equipment. *Proc. Inst. Food Technol.*, pp. 45-51. 1943.

This paper is devoted to certain aspects of dryers and drying methods with special reference to tray and tunnel drying. It is emphasized that the dryer must be fitted to the job it has to perform. The kinds of jobs vegetable dryers have to perform are classified. On the basis of these, a definition of a good tray dryer is provided; counterflow tunnel dryers are discussed; and a brief comment on the probable evolution of design as applied to tray and tunnel dryers is given.

Blanching: See also 17(4):384-386, 478, 480, 482, 484, 486. April, 1945.

- H. Campbell, H. Lineweaver, and H. J. Morris. Severe blanch doesn't improve dehydrated potato quality. *Food Indus.* 17(4):384-386, 478, 480, 482, 484, 486. April, 1945.

Blanching potatoes prior to dehydration improves storage and rehydration characteristics and reduces loss of quality during processing. However, storage quality of dehydrated white potatoes is not improved by severe blanching or by completely inactivating the peroxidase enzyme system. Presence of residual peroxidase in the dehydrated product, even to the extent found in the potatoes blanched for the shortest time, is of little moment. Potatoes blanched for 10 minutes had no better keeping quality than potatoes blanched for 1 or 2 minutes. Below 70° F., temperature does not markedly affect rate of quality deterioration. A storage temperature as high as 90° F. for long periods of time is undesirable, especially from the standpoint of color change. Some lots of potatoes are more subject to over-blanching or the so-called "popcorn" effect than others. From the work of Freeman, the popcorn effect appears to be related to the degree of mealiness in the raw stock. Exceptionally mealy potatoes are not suitable for dehydration purposes.

Sulfuring: See also 17(9):100-101. Sept., 1945.

- E. A. Beavens and J. A. Bourne. Commercial sulfiting practices. *Food Indus.* 17(9):100-101. Sept., 1945.

Dehydration plants in Southern California treat carrots and cabbage with sulphit solutions to retain flavor, color, and vitamin content. A continuous sulphiting line for treating vegetables before blanching is used in these plants. The solution is fed to the spray from an overhead steam-jacketed kettle equipped with

an electronic level controller. It is pumped into this kettle from two storage tanks equipped with agitators, passing through a filter after it leaves the stainless-steel pump.

- G. Mackinney and L. B. Howard. Sulphite retards deterioration of dehydrated cabbage shreds. *Food Indus.* 16(5):355-356, 406-409. May, 1944. (With Univ. Calif.).

In this study, an economically feasible and practical method of sulphiting was sought which could be readily applied by plants working under severe wartime handicaps with respect to available equipment and competent trained personnel. This paper presents a specific example of such a method and the value of the process with respect to retarding deterioration of a dehydrated product, in this instance cabbage.

- A. N. Prater, C. M. Johnson, M. F. Pool, and G. Mackinney. Determination of sulfur dioxide in dehydrated foods. *Indus. and Engin. Chem., Analyt. Ed.* 16(3):153-157. March, 1944. (With Univ. Calif.).

As a control measure in the application of sulfite solutions to vegetables for dehydration, a simple method for determining the sulfur dioxide content has become necessary. The method proposed in this paper was designed for inspection and field work with a minimum of equipment, but it is also well adapted to laboratory research. It has been checked against other methods and also by the polarograph.

- D. G. Sorber. The relation of the sulfur dioxide and total sulfur contents of dried apricots to color change during storage. *Fruit Prod. Jour. and Amer. Food Mfr.* 23(8):234-237, 251. Apr., 1944.

Growers in certain regions encounter difficulties in sulfuring their fruit sufficiently to give it a satisfactory color. Studies have been made of the closely associated problem of rapid color decline after sulfuring which occurs under some storage conditions, especially in warm humid atmospheres such as are most common in the tropics. This paper presents the results of storage studies conducted at the Laboratory of Fruit and Vegetable Chemistry. Four sets of apricots, each set representing three lots, were dried during the 1930 season for use in storage tests. One lot in each set was unsulfured and dried in the sun. Of the duplicate sulfured lots of each set, one was dried in the sun and the other in the shade. The sulfuring process applied to fruit of the different sets varied as to the concentration of sulfur dioxide in the atmosphere to which the fresh apricot halves were exposed and as to the duration of exposure. Sulfur dioxide, sulfate sulfur, and total sulfur were quantitatively determined in all samples after 5 days of drying, and after 17 months and 10½ years of storage. The sulfur dioxide decrease to less than 10 percent of its original amount in all of the sulfured samples during the longer storage period. The sulfur resulting from the decrease of the sulfur dioxide combined with some fruit constituent to form a stable, non-volatile compound. Unsulfured fruit was dull and dark brown, resulting from the activity of the oxidase enzyme. Sulfured apricots after prolonged storage were black on the surface and had a pronounced odor and slight flavor of caramelized sugar. The freshly torn surfaces of the sulfured fruit pieces were dark brown. The very dark color of the sulfured fruit after long storage at room temperatures may be due in part to the browning resulting from the reactivation of the oxidase enzyme following diminution of the sulfurous acid content, and in part to the destruction of the fruit sugars by sulfuric acid resulting from the oxidation of the sulfurous acid.

Principles of Dehydration:

- *B. Makower and G. L. Dehority. Equilibrium moisture content of dehydrated vegetable *Indus. and Engin. Chem.* 35(2):193-197. Feb., 1943.

The equilibrium moisture content of some dehydrated vegetables was determined by allowing them to attain equilibrium in air-free desiccators containing sulfuric acid solutions to control the relative humidity. Adsorption and desorption measurements were carried out on unblanched carrots, cabbage, yams, spinach, and white potatoes. The sorption isotherms for all the vegetables are S-shaped, and are characterized by an inflection point in the neighborhood of 5 percent moisture content. Measurements were also made on blanched white potatoes. Blanching causes a decrease in the equilibrium moisture content. The decrease is ascribed to a change in the physical state of the starch granules in the potato. Application of the sorption data to dehydration and packaging of vegetables is briefly discussed.

- *J. R. Matchett. Progress in spray drying of fruits and vegetables. *West. Canner and Packer* 38(1):71-72. Jan., 1946.

Spray drying is a process designed to desiccate almost instantaneously products which would be harmed by prolonged exposure to high temperatures or those whose characteristics do not lend themselves well to other means of dehydration. The process of spray drying, which is used extensively for the dehydration of milk and exclusively for the dehydration of eggs, may prove to be well adapted to the removal of moisture from other fluid food products that are easily injured by heat. In this process dehydration is accomplished within a few seconds by suspending finely atomized fluid in a stream of hot air and collecting the resulting dry product as a powder.

Quality Control:

- A. H. Brown and P. W. Kilpatrick. Drying characteristics of vegetables--riced potatoes. *Trans. Amer. Soc. Mech. Engin.* 65(11):837-842. Nov., 1943.

The food necessities of the recent war motivated the dehydration of foods on a scale never before undertaken. Early in the War comparatively little information was available in the literature. This paper, taking account of the shortage of construction materials, reports experimental data upon which basis dehydrators could be designed and built. The equipment involved, the conditions of the investigation, as applied to the dehydration of riced potatoes, and the analysis of experimental results led to the presentation of a rational theory of dehydrator design and operation.

- H. Campbell and P. W. Kilpatrick. Effect of storage temperatures on sensitivity of White Rose potatoes to processing heat. *Fruit Prod. Jour. and Amer. Food Mfr.* 24(4):106-108. 120-121. Dec., 1945.

In commercial and experimental dehydration of white potatoes, considerable variation has been observed between lots with respect to sensitivity to heat damage during dehydration under similar conditions. Heat damage is characterized by reddening or browning of the dried tissues, especially in the centers of strips and cubes. This paper reports that the variability observed between lots of commercially and experimentally dehydrated potatoes with respect to sensitivity to heat damage when dehydrated under normal conditions can be attributed in part to storage of the raw stock at temperatures that permit the accumulation of sugars. The sensitivity of potatoes to heat damage resulting from low-temperature storage can be reduced by subsequent storage at an elevated temperature prior to dehydration. Sensitivity to heat damage resulting from low-temperature storage is associated with an accumulation of total and reducing sugar in the raw stock.

The condition appears to be more closely related to the accumulation of reducing sugar than to total sugar. Reducing-sugar determinations on the raw stock may be useful as an index of sensitivity to heat damage. As such they may be used as basis for the purchase of raw stock and as a means of predetermining the need for special treatment in preparation and dehydration.

M. E. Davis and L. B. Howard. Effects of varying conditions on the reconstitution of dehydrated vegetables. *Proc. Inst. Food Technol.*, pp. 143-155. 1943.

The implications of various terms which have been applied to the process of replacing water in dehydrated vegetables are discussed in this paper. Some of the changes which occur in this process may be measured quantitatively and expressed mathematically by several different ratios or coefficients. Acceptable techniques in rehydration tests must provide for: (1) time and temperature sequences suitable to the material and compatible with optimum quality in each sample; (2) enough water to submerge the pieces without excessive amounts being present at the end of the test; (3) shaking or stirring when necessary to insure wetting of all the pieces during the test; (4) control of the rate of heating so as to prevent rapid and variable losses of water during boiling; and (5) a relatively pure water supply of constant composition. The authors discuss the relationship between blanching and the rates of rehydration and cooking, and effects of varying the temperature, the time of drying, and lowering or raising moisture content in finished dried carrots. Multiple rehydration tests under different time and temperature conditions were necessary to fully evaluate the influence of the numerous factors which are associated with rehydration phenomena.

W. C. Dunlap, Jr. and B. Makower. Radio-frequency dielectric properties of dehydrated carrots. Application to moisture determination by electrical methods. *Jour. Phys. Chem.* 49(6):601-622. Nov., 1945.

Few comprehensive studies have been made of radio-frequency properties of vegetable materials containing absorbed water. This paper reports measurements made of the radio-frequency dielectric properties of dehydrated carrots. Dielectric constant and specific conductivity (a.c. and d.c.) as functions of moisture content (1.5-24.3 percent), temperature (1.2-39.8°C.), frequency (18 kc. to 5 mc.), density (0.760-1.38 g. per cubic centimeter), and particle size were measured. Use of various variables, including direct-current conductivity, dielectric constant, impedance, dielectric loss, and power-factor measurements, for measurement of moisture content of organic materials containing adsorbed water is discussed. Although the d.c. conductivity is the most sensitive to moisture, its low average value and high sensitivity to temperature make it unsuitable for moisture determination. In general, the variables other than d.c. conductivity appeared to be nearly equivalent for moisture determination. In all cases except for dielectric constant at low moistures, a high radio frequency is most suitable.

*H. J. Dutton, G. F. Bailey, and E. Kohake. Dehydrated spinach. Changes in color and pigments during processing and storage. *Indus. and Engin Chem.* 35(11):1173-1177. Nov., 1943.

Experiments have shown that, in unblanched dehydrated spinach, destruction of chlorophyll is positively correlated with moisture content and is affected very little by oxygen content of the storage atmosphere. The destruction of carotene is, however, greatly dependent upon oxygen in the storage atmosphere and independent of moisture content of the dried product. The destruction of chlorophyll may be regarded as an indication of loss of palatability and ascorbic acid, but does not indicate loss of carotene. Because changes in color due to changes in chlorophyll obscure changes in color due to changes in carotene content, there is little possibility of correlating carotene content with spectral reflectance measurements.

- *L. B. Howard. Significance of moisture content of dehydrated vegetables. *Canner* 100(13):46, 48, 50. Feb., 1945.
Reasons for dehydrating to low moisture levels, methods for determining moisture content, moisture content and keeping quality of dehydrated products, tests to determine deterioration, and a description of "in-package" desiccation are presented in this paper.
- *H. J. Loeffler and J. D. Ponting. Ascorbic acid. Rapid determination in fresh, frozen, or dehydrated fruits and vegetables. *Indus. and Engin. Chem., Analyt. Ed.* 14(11):846-849. Nov., 1942.
(See Freezing Section).
- *B. Makower and S. Myers. A new method for the determination of moisture in dehydrated vegetables. *Proc. Inst. Food Technol.*, pp. 156-164. 1943.
Accurate control of the moisture content is of great importance to the dehydration industry. The widely employed vacuum-oven method for moisture determination which was originally developed for dried fruits by the A.O.A.C. (6 hours at 70° C.) does not even give a good approximation. In this paper experiments are described to show how seriously the results are affected by fineness of grinding of the sample and by time of heating, temperature, and pressure. Carrots ground to 40 mesh (optimum fineness) require at least 40 hours for accurate determination, which is considered to be objectionably long. It is therefore proposed that the vapor pressure of water rather than the percentage of water be adopted as an index of the moisture level. A simple apparatus is described for the measurement of the vapor pressure. The advantages are that the sample does not require weighing, the results are independent of the fineness of grinding, and the measurement may be completed in approximately two hours. The relations between vapor pressure and the moisture content are shown for dehydrated carrots and spray-dried eggs.
- *J. P. Nielsen. Rapid determination of starch in vegetables. *Indus. and Engin. Chem. Analyt. Ed.* 15(3):176-179. March, 1943.
(See Freezing Section).
- *J. P. Nielsen and P. C. Gleason. Rapid determination of starch. Factors for starches and comparison with acid and enzymic hydrolysis methods. *Indus. and Engin. Chem., Analyt. Ed.* 17(3):131-134. March, 1945.
(See Freezing Section).
- *J. D. Ponting. Extraction of ascorbic acid from plant materials. Relative suitability of various acids. *Indus. and Engin. Chem., Analyt. Ed.* 15(6):389-391. June, 1943.
The stabilization of ascorbic acid during its extraction and determination has long been a problem. Of the 13 acids compared as to their stabilizing effect on ascorbic acid solutions under conditions favorable to oxidation, only metaphosphoric and oxalic acids appeared suitable, these two acids being far superior to any of the others and about equally satisfactory. It is concluded that oxalic acid may be safely substituted for metaphosphoric acid in the determination of ascorbic acid, thus providing a more stable, more easily obtainable, and less expensive extractant.
- *R. M. Reeve. A microscopic study of physical changes in carrots and potatoes during dehydration. *Food Res.* 8(2):128-136. Mar.-April, 1943.
Preparation of the vegetable tissues for microscopic examination after different periods and techniques of drying was accomplished by a modified celloid technique by which the dehydrated condition was preserved. The extent of shrinkage during dehydration, and the differences between blanched and unblanched,

dehydrated vegetables are described, using carrots and potatoes as types of low-starch and high-starch vegetables, respectively. Case hardening is conditioned by rapidity of evaporation, cell contents, and the thickness of the slices or cubes prepared for drying. Blanching of potato causes starch gelation and the gelled starch seals the dehydrated tissues. Incomplete gelation of starch contents causes lumpiness in the reconstituted product. Forced drying also produces other undesirable effects. Because of the more uniform rate of evaporation obtained and because of uniform starch gelation, steam blanching of thin pieces of vegetable is desirable prior to commercial dehydration.

- *R. M. Reeve. Microscopy of oils and carotene bodies in dehydrated carrots. *Food Res* 8(2):137-145. Mar.-Apr. 1943.

The fixed oil of carrot occurs in the fresh tissues in a lipoprotein association. Blanching and dehydration break down the lipoprotein and free the oil in which some of the carotene dissolves. Some of the off odors of dehydrated carrot are related to oil and carotene oxidation. Preservation of carotene in the blanched, dehydrated carrot is partially effective according to the amount of carotene dissolved in and coated by the oil, and also according to the rate at which the oils oxidize. Unblanched, dehydrated carrots contain less oil-protected carotene. Blanching causes earlier and more complete liberation of oil, which coats and protects the carotene, because of the greater length of time in which it can occur and also because of the greater mobility of substances in the denatured cytoplasm. Dipping in weak solutions of dextrin and pectin prior to dehydration increases the carotene retention in unblanched carrot, but such protection afforded by the pectin is only superficial.

- *R. M. Reeve. Changes in tissue composition in dehydration of certain fleshy root vegetables. *Food Res.* 8(2):146-155. Mar.-Apr., 1943.

Microscopic evidence correlated with results of chemical analyses indicates that preservation of carotenoids (provitamin A) in certain vegetables is favored by blanching before dehydration. Case-hardening effects induced by blanching of starchy vegetables can be remedied by thin slicing. Beneficial effects of blanching are: less vitamin loss occurs and the enzymes are inactivated so that certain undesirable changes are minimized. Histological studies show a definite correlation between blanching and rate of carotene oxidation upon storage of the dried product, particularly in starchy vegetables. This correlation is established by comparisons of low-starch vegetables with starchy vegetables as to oil protection of the carotene and as to the protective action of gelled starch on both oils and carotene in sweet potatoes. Blanching denatures the cytoplasm of raw slices and there is a greater amount of pectin solution soaked up by blanched slices than by raw. Experimental treatments with pectin by dipping are further justified by the hypothesis that the pectic content of beets provides a protective sealing effect in blanched, dried tissues.

- F. Stitt and E. K. Kennedy. Specific heats of dehydrated vegetables and egg powder. *Food Res.* 10(5):426-436. Sept., 1945.

In the course of an investigation of heat transfer through dehydrated vegetables and egg powder, values of the mean specific heats of these materials between room and dehydrator temperatures were required. Mean specific heats of seven dehydrated vegetables and of egg powder were measured for the temperature interval 27 to 66° C. Measurements between 0 and 27° C. were also made on four of these materials. The heat capacity was found to exceed the sum of the heat capacities of the equivalent quantities of dry solid and water by an amount which varies with

moisture content in different ways for dehydrated carrots, eggs, and potatoes. These positive deviations from additivity are discussed with regard to origin, thermodynamic significance, and interpretation in terms of "bound water" content.

- R. H. Wilson, J. O. Thomas, and F. DeEds. Vitamin A value of fresh and dehydrated carrots. *Fruit Prod. Jour.* 22(11):15-17. Sept., 1942.

This paper is concerned with the vitamin A value of fresh and dehydrated carrot of the Chantanay variety. The parallelism between the chemical and biological methods for evaluating vitamin A both before and after a processing technique is studied.

Packaging:

- *A. L. Pitman, W. Rabak, and H. Yee. Packaging requirements for dehydrated vegetables. *Food Indus.* 15(1):49-52. 104. Jan., 1943.

What a package must do to protect the quality of dehydrated vegetables is explained in this article. The authors give the relative performance of various materials as determined by tests at the Western Regional Research Laboratory.

Related Processes:

- L. B. Howard and H. Campbell. Dehydrofreezing---new way of preserving food. *Food Indus.* 18(5):674-676. May, 1946.

Experiments with several fruits and vegetables have shown that moderate dehydration (removal of about two-thirds of the water content) followed by freezing storage resulted in excellent products in most cases. Advantages of this new method, tentatively called dehydrofreezing, are savings in weight, space, packaging materials, and refrigeration load. The preliminary experiments have dealt with potatoes, peas, carrots, asparagus, cherries, boysenberries, and apricots.

STUDIES ON EGGS

- G. Alderton and H. L. Fevold. Preparation of the egg yolk lipoprotein, lipovitellin. *Arch. Biochem.* 8(3):415-419. Dec., 1945.

A convenient method for the preparation of the lipoprotein from egg yolk which consists of collecting the crude lipoprotein by passing diluted egg yolk through a Sharples centrifuge and extracting the precipitate with cold ether is here presented. The product thus obtained contains, in addition to lipovitellin, phosphorus-containing substances, which are removed by solution in 10 percent sodium chloride and precipitation by dialysis. The analytical data for the final product agree well with published values. Approximately 18 percent of egg yolk solids was found to be lipovitellin; roughly 17 percent was isolated by the reported method. The lipoprotein contains approximately 16 to 18 percent of a phosphatide, which appears to be largely lecithin.

- *M. M. Boggs, H. J. Dutton, B. G. Edwards, and H. L. Fevold. Dehydrated egg powder. Relation of lipide and salt-water fluorescence values to palatability. *Indus. and Engin Chem.* 38(10):1075-1079. Oct., 1946.

The effects of decreasing moisture content, gas packing, acidification, and acidification plus gas packing, on the shelf life of dehydrated egg powders during storage at 36.5° C., are reported in this paper. "Shelf life" is defined as the time of storage during which the egg powders remain acceptable for consumption as scrambled eggs. Egg powders of lower moisture content retain their palatability better than those containing more moisture. Packing in nitrogen or carbon dioxide increases the shelf life two- and fourfold, respectively. Acidification of egg emulsion to pH 5.5 before drying resulted in a two- to threefold increase

in shelf life over unacidified powders. Acidification plus carbon dioxide or nitrogen packing brings about the best retention of palatability during storage, the shelf life being five to six times that of nonacidified air-packed egg powders. Also, acidified spray-dried powders retain good beating properties in contrast to nonacidified spray-dried powders.

- *M. M. Boggs, H. J. Dutton, B. G. Edwards, and H. L. Fevold. Dehydrated egg powder. Relation of lipid and salt-water fluorescence values to palatability. *Indus. and Engin. Chem.* 38(10):1082-1084. Oct., 1946.

This paper presents the results of experiments to evaluate the palatability of egg powders objectively. To evaluate the reliability of fluorescence determinations as indices of palatability, fluorescence values for salt water (NaCl) and ether extracts of freshly prepared and stored dehydrated egg powders have been determined and compared with the palatability scores for the same egg powders. Salt-water fluorescence values for stored egg powders were found to correlate well with palatability scores for high moisture (4 to 5 percent) egg powders, but the correlation was poor for egg powders below 2 percent moisture. Lipid fluorescence values, on the other hand, correlated well with palatability scores for high and low moisture powders during storage, and the correlation was also better for lipid fluorescence when all classes and grades of egg powders are considered. Because of these facts, and since the lipid-soluble fluorescing substance and the substance mainly responsible for loss of palatability both apparently originate in the phospholipide fraction of the egg powders, lipid fluorescence values are believed to be better criteria of palatability than salt-water fluorescence values.

- H. J. Dutton and B. G. Edwards. Changes in stored dried eggs. Spectrophotometric and fluorometric measurement of changes in lipides. *Indus. and Engin. Chem.* 37(11):1123-1126. Nov., 1945.

Changes in color of the lipid fraction of dehydrated egg during storage arise presumably from three chemical changes: destruction of naturally occurring carotenoid pigments, production of yellow-to-brown materials from unsaturated fatty acid groups, and development of brown products resulting, probably, from the interaction of amine and aldehyde groups of lipides. While carotenoid destruction results in loss of color, the other two changes tend to darken the color of the dried egg product. Changes that occur in the lipid fraction of dehydrated eggs during storage were studied by spectrophotometric and fluorometric techniques. The reaction of lipid amines with aldehydes, the destruction of carotenoids, and a process that has been interpreted as polymerization of the unsaturated fatty acids were found to proceed faster at 98° than at 70°; little change was detected at 15° F. The fluorescing substance that develops in the fat of dehydrated eggs during storage has been tentatively identified as the reaction product of lipid amines with aldehydes.

- H. J. Dutton and B. G. Edwards. Determination of carotenoids and lipid amine-aldehyde products in dehydrated egg. *Indus. and Engin. Chem., Analyt. Ed.* 18(1):38-41. Jan., 1946.

Loss of carotenoid indicates oxidative degradation in stored egg powder. In the present paper a combined spectrophotometric fluorometric method is presented by which carotenoids and lipid amine-aldehyde products can be determined directly upon the ether extract of egg powder without recourse to saponification and solvents partition. A spectrophotometric method for the determination of carotenoid content and a fluorometric method for the determination of ether-soluble brown products in powdered eggs are described. The development of brown lipid substances in stored egg powders introduces errors into the direct photometric measurement of carotenoids; however, these errors are minimized by the spectrophotometric procedure described. Both determinations can be performed upon a single ether extract of egg powder.

- H. J. Dutton and B. G. Edwards. Changes in color of dehydrated eggs during storage. *Indus. and Engin. Chem.* 38(3):347-350. March, 1946.
Color changes from yellow to brown during storage of dehydrated eggs were studied spectrophotometrically by reflectance and absorption measurements. The influence of the simultaneous destruction of carotenoids and formation of brown aldehyde-amine substances upon the reflectance of egg powders is discussed. The lipid amine-aldehyde reaction is dependent on moisture content, whereas rate of carotenoid destruction is independent of moisture content. Both reactions are accelerated by increasing temperature of storage. An approximately linear relation has been observed between negative logarithm of the reflectance of residues after ether extraction and fluorescence of salt extracts of the residues. This linearity confirms the conclusions previously drawn from experiments with model systems that the salt-extractable fluorescent compound, which has been used as an index of palatability, is the brown "glucose-protein" reaction product.
- B. G. Edwards and H. J. Dutton. Changes in stored dried eggs. Role of phospholipides and aldehydes in discoloration. *Indus. and Engin. Chem.* 37(11):1121-1122. Nov., 1945.
Dehydrated egg powders tend to acquire a brown color during storage. In a study of the sources of this discoloration, an ether-soluble brown substance has been traced to the cephalin fraction of the phospholipides. Evidence obtained by this Laboratory and presented in this paper supports the hypothesis that this substance is the product of a reaction of an aldehyde with an amino constituent of the cephalin fraction.
- *H. L. Fevold, B. G. Edwards, A. L. Dimick, and M. M. Boggs. Dehydrated egg powders. Sources of off-flavors developed during storage. *Indus. and Engin. Chem.* 38(10):1079-1082. Oct., 1946.
This paper reports that egg white does not contribute materially to the loss of palatability during storage. Egg yolk does deteriorate and imparts the characteristic "stored" flavor to the reconstituted egg powder. Of the egg yolk components, the proteins, lipovitellin, and livetin do not develop stored flavor and odor. The phospholipide fraction of the lipides does undergo characteristic deteriorative changes and seems to be the source of substances imparting off-flavors and off-odors to stored egg powders. The phospholipide-free lipides develop marked rancidity changes when stored separately, which do not take place in the presence of the phospholipides. It thus appears that the phospholipides act as antioxidants, but in so doing undergo changes which impart characteristic off-flavors and off-odors to the egg powder. Salt-water fluorescence measurements of the recombined whole egg powders show that the fluorescing substance arises in the egg white rather than in the egg yolk. The reliability of this criterion for palatability determination is therefore questionable.
- L. Kline and C. M. Johnson. Factors influencing estimation of free fatty acids in dried egg powders. *Indus. and Engin. Chem., Analyt. Ed.* 18(1):35-38. Jan., 1946.
A study in this Laboratory of lipolytic activity in stored dried egg powders necessitated the use of a specific method for measuring glyceride hydrolysis. At the normal pH of dried whole egg, fatty acids liberated during storage are incompletely estimated by the A.O.A.C. procedure for determination of acidity of the ether extract. In addition, the contribution of the extracted cephalin to the acidity of the ether extract may obscure significant percentage increases in the free fatty acidity of the egg powder. The necessity for drying the egg powder as required in the A.O.A.C. procedure is re-emphasized.

- A. A. Klose, G. I. Jones, and H. L. Fevold. Vitamin content of spray-dried whole egg. *Indus. and Engin. Chem.* 35(11):1203-1205. Nov., 1943.
Spray drying of emulsified whole eggs, as practiced in most of the commercial drying units from which samples were obtained, has no significant destructive action on the vitamins contained in the egg; namely, vitamins A and D, thiamin, riboflavin, pantothenic and nicotinic acids. Vitamin A was found to be unstable during storage of dehydrated eggs; after 9 months 80 percent was lost at 15°F., 75 at 70°, and 80 at 98.6°. Pantothenic and nicotinic acids were quite stable during 9 months of storage of spray-dried whole eggs under the conditions used in these experiments. Only slight destruction of riboflavin occurred at 98.6°F. during the 9 months and essentially none at lower temperatures. Thiamine in spray-dried whole eggs was stable at 15° F. for 9 months; during the same period the losses were 46 percent at 70° F., and 50 at 98.6°.
- B. Makower. Vapor pressure of water adsorbed on dehydrated eggs. *Indus. and Engin. Chem.* 37(10):1018-1022. Oct., 1945.
Knowledge of the vapor pressure of water over dehydrated eggs is essential in the design of drying equipment for eggs and in the selection of packaging material for the dry product. Equilibrium pressure of water vapor over spray-dried whole eggs was determined at six temperatures varying from 17.1° to 70° C. and at moisture contents ranging from 0.5 to 5.5 percent. The results agreed well with similar data on eggs dried from the frozen state and with the less extensive data published by Gane. The results were analyzed by a graphical method suggested by Othmer, and from this analysis was derived the isosteric heat of adsorption of water on dried eggs at various moisture levels. The ratio of the isosteric heat to the latent heat of condensation of water vapor increases from 1.1 to 2.1 as the moisture content decreases from 5.5 to 0.5 percent. It was also shown that the adsorption isotherms can be represented, within certain limits, by the Brunauer, Emmett, and Teller theory of adsorption of gases on solids.
- H. S. Olcott and H. J. Dutton. Changes in stored dried eggs. Source of fluorescence. *Indus. and Engin. Chem.* 37(11):1119-1121. Nov., 1945.
During the past few years it has become increasingly apparent that the brown color which develops in food products during storage is in part the result of a condensation of reducing sugars with proteins and protein hydrolytic products. The fluorescence of 10 percent salt extracts of dried eggs was used as a simple criterion of palatability. This fluorescence, the source of which has not been recognized, appears to be due to the brown reaction products of glucose and the free amino groups of proteins. Similar fluorescing brown products also result from the interaction of simple amines and aldehydes. These can be used as model systems for the study of the glucose-protein reaction.
- T. M. Shaw, A. R. Vorkoeper, and J. K. Dyche. Determination of surface area of dehydrated egg powder. *Food Res.* 11(3):187-194. May-June, 1946.
This paper reports the low temperature-gas method and the permeability method used to determine the surface areas of representative spray-dried and lyophilized egg powders. The surface areas found by the low temperature-gas adsorption method range from about 9.1 to 9.8 square meter per gram. Lyophilized powders have larger areas than spray-dried powders. The permeability method is shown to be unsatisfactory for the accurate determination of the surface areas of dehydrated egg powders because of an anomalous dependence of surface area on the porosity to which the eggs are packed in the permeability cell.
- F. Stitt and E. K. Kennedy. Specific heats of dehydrated vegetables and egg powder. *Food Res.* 19(5):426-436. Sept., 1945. (See Dehydration).

BY-PRODUCTS, TECHNICAL INVESTIGATIONS, AND BASIC STUDIES

Mimeographed information:

- 14 Recovery of tartrates from grape wastes. Aug., 1943. Rev. Dec., 1946.
- 28 Preparation of a liquid apple pectin concentrate. Sept., 1943.
- 70 A process for production of asparagus-juice concentrate. Feb., 1945.
- 106 Production, concentration, properties, and assay of the antibiotic, subtilin. Jan., 1946.
- *119 Glutamic acid review and bibliography. Aug., 1946.

Journal articles:

Antibiotics:

- K. P. Dimick. A quantitative method for the determination of tyrothricin. *Jour. Biol. Chem.* 149(2):387-393. Aug., 1943.
Investigations undertaken in this Laboratory concerning the usefulness of vegetable juices as media for growing antibiotic-producing organisms required a rapid and accurate method for the quantitative determination of tyrothricin. In this paper a quantitative method, based upon the hemolytic action of tyrothricin, is described for the determination of tyrothricin in culture media. This method is accurate to within 5 percent, as determined by recovery experiments, and as little as 100 γ of tyrothricin per ml. of culture can be measured. One ml. of culture is sufficient for test purposes. Isolation studies indicate that about 75 percent of the activity of a culture is obtained by the ordinary extraction procedures.
- H. Humfeld and I. C. Feustel. Utilization of asparagus juice in microbiological culture media. *Proc. Soc. Expt. Biol. and Med.* 54(2):232-235. 1943.
This paper reports the suitability of press juices prepared from waste asparagus butt trimmings as a source of the major components of media for culturing certain microorganisms of potential commercial importance. The use of such media for the production of certain antibacterial substances and proteolytic enzymes is projected.
- *E. F. Jansen and D. J. Hirschmann. Subtilin—an antibacterial product of *Bacillus subtilis*. *Arch. Biochem.* 4(3):297-309. July, 1944.
Certain strains of *Bacillus subtilis* have been known for many years to be antagonistic to a number of pathogenic and non-pathogenic bacteria and fungi. A strain of *B. subtilis* was investigated in this Laboratory because a crystalline product, apparently a polypeptide similar chemically to tyrothricin, was obtained directly from one of the first cultures when it was fractionated by the same procedure as used to obtain tyrothricin from *Bacillus brevis*. The product has been extracted from the dried organisms with warm ethanol. Sterilized cultures of *B. subtilis* retain their antibacterial activity for 12 days when standing in the dark at room temperature, but lose 90 percent of their activity in the light. The active substance is fairly heat stable. It appears to be most stable in the acid region near pH 2.5, being unstable above pH 7. Its stability properties and rapid rate of diffusion distinguish it from tyrothricin. The active product of *B. subtilis* has been called subtilin for convenience, although the activity is probably due to more than one substance.
- J. C. Lewis, K. P. Dimick, I. C. Feustel, H. L. Fevold, H. S. Olcott, and H. Frankel Conrat. Modification of gramicidin through reaction with formaldehyde. *Science* 102(2646):274-275. Sept., 1945.
The toxicity of tyrothricin and of its components, gramicidin and tyrocidine has been a limiting factor in the general applicability of these antibacterial agents.

in medicine. It is reported in this paper that the treatment of tyrothricin with formaldehyde resulted in a loss of 80 to 90 percent of the original hemolytic activity and a loss of up to 50 percent of the antibiotic activity. The action of formaldehyde on gramicidin gave a similarly reduced hemolytic effect; but the antibiotic activity, estimated with *Staphylococcus aureus*, was found to be unchanged. Preliminary tests with rats (intraperitoneal injections) indicated that the modified gramicidin was considerably less toxic than untreated gramicidin.

- J. C. Lewis, K. P. Dimick, and I. C. Feustel. Production of tyrothricin in culture of *Bacillus brevis*. *Indus. and Engin. Chem.* 37(19):996-1004. Oct., 1945.

Tyrothricin, an antibiotic material formed during the growth of *Bacillus brevis* is now produced commercially for medical and veterinary uses. This paper reports that yields of tyrothricin in excess of 2 grams per liter of medium were obtained through the growth of *Bacillus brevis* in shallow layers of medium. Maximum yields were found after 10 or 16 days of incubation at about 35° C. with the medium disposed in 11-mm. layers. Complex sources of nitrogen, such as Bacto tryptone, acid hydrolysate of casein, corn-steep liquor, tryptic digest of soybean meal, and press juice concentrates from waste asparagus butts, proved most suitable; relatively simple substances, such as glutamic acid, asparagine, or ammonium sulfate plus citric or malic acid, proved moderately effective in the presence of 0.2 percent Bacto tryptone. About 3 to 5 percent of a fermentable carbon compound, such as glucose, mannitol, or glycerol, was necessary for best yields; fructose, sucrose, lactose, and maltose proved much less effective. Requirements for calcium, magnesium, and manganese were demonstrated. Unlike the other nitrogen sources mentioned, properly processed asparagus concentrates yielded nutritionally complete media without addition of sugar or inorganic elements.

- H. S. Olcott, J. C. Lewis, K. P. Dimick, H. L. Fevold, and H. Fraenkel-Conrat. Succinic acid derivatives of gramicidin and methylol gramicidin. *Arch. Biochem.* 10(3):553-555. Aug., 1946.

In this paper a reaction product of gramicidin and formaldehyde with properties of possible therapeutic interest is reported.

Basic Studies

- M. E. Davis, E. M. Chace, and C. G. Church. Protein and sulfur content of immature lima beans (*Phaseolus lunatus*) as affected by varietal and environmental factors and processing. *Food Res.* 7(1):26-37. Jan.-Feb., 1942.

This paper reports that environment and water balance, rather than heredity, determine the levels at which nitrogen and sulfur occur in immature, green lima beans. There is slight change in the nitrogen and sulfur fractions of the total solids because of removal of white, immature beans or because of blanching, freezing, and drying processes.

- *H. L. Fevold and A. Lausten. Isolation of a new lipoprotein, lipovitellenin, from egg yolk. *Arch. Biochem.* 11(1):1-7. Sept., 1946.

This paper reports the isolation of a new lipoprotein of egg yolk. The lipoprotein, which has been called lipovitellenin, contains 36-41 percent alcohol-extractable phospholipid as compared to 16-18 percent for the previously recognized lipoprotein, lipovitellin. Lipovitellenin dissolves to an opalescent solution in 10 percent NaCl but to a clear yellow solution in 10 percent NaCl saturated with ethyl ether. The new lipoprotein comprises roughly 40 percent of the total lipoprotein of egg yolk and 12-13 percent of the egg yolk solids. The protein component (vitellenin) of the lipoprotein is a phosphoprotein similar to vitellin in general solubility behavior. It contains, however, less than one-third as much phosphorus as does vitellin.

H. Fraenkel-Conrat and H. S. Olcott. o-Biphenyl isocyanate, o-Bicyclohexyl isocyanate, N,N'-Di-o-biphenyl urea, N,N'-Di-o-bicyclohexyl urea. *Jour. Amer. Chem. Soc.* 66(5):845. May, 1944.

This paper presents methods for synthesizing the new compounds named.

*E. F. Jansen and R. Jang. Esterification of galacturonic acid and polyuronides with methanol-hydrogen chloride. *Jour. Amer. Chem. Soc.* 68(8):1475-1477. Aug., 1946
The data reported in this paper are concerned with relative rates of glycoside formation and esterification at 0° and at 24-25° of galacturonic acid in absolute methanol containing various concentrations of dry hydrogen chloride. The esterification of galacturonic acid in methanol containing small concentration of hydrogen chloride (0.005 to 0.1 N) proceeded at a rate at least 25 times more rapid at 25° and 55 times more rapid at 0° than did glycoside formation. Both reactions were first order to at least 50 percent conversion and the energies of activation for the esterification and glycoside formation reactions were $14,000 \pm 700$ and $21,000 \pm 1,000$ cal., respectively. Methyl α -D-galacturonate was isolated in good yields from such reaction mixtures. Alginic acid was partially esterified by a similar procedure. However, pectic acid under the same conditions was only very slowly esterified.

F. T. Jones. Optical and crystallographic properties of lysozyme chloride. *Jour. Amer. Chem. Soc.* 68(5):854-857. May, 1946.

This paper reports the optical and crystallographic properties of single crystals of lysozyme chloride determined on air-dried and on wet crystals. The refractive indices have been found to vary with moisture content, but the birefringence remains constant.

*F. T. Jones and L. M. White. The composition, optical and crystallographic properties of two calcium oxalate-chloride double salts. *Jour. Amer. Chem. Soc.* 68(17):1339-1342. July, 1946.

In this paper a microscopical study of the reaction of calcium oxalate with hydrochloric acid is reported. The composition, optical and crystallographic properties, and X-ray lines of a new double salt, $\text{CaC}_2\text{O}_4 \cdot \text{CaCl}_2 \cdot 2\text{H}_2\text{O}$, and those of the previously reported double salt, $\text{CaC}_2\text{O}_4 \cdot \text{CaCl}_2 \cdot 7\text{H}_2\text{O}$, were determined. The formation of these crystalline materials can be used as an aid in the microscopical identification of calcium oxalate, and to aid the phase study of this system.

H. P. Lundgren, D. W. Elam, and R. A. O'Connell. Electrophoretic study of the action of alkylbenzene sulfonate detergents on egg albumin. *Jour. Biol. Chem.* 149(1):183-193. July, 1943.

Results of electrophoretic analysis of an egg albumin-alkylbenzene sulfonate system permit the following conclusions: Both native and heat-denatured egg albumin form complexes of well-defined electrophoretic patterns with alkylsulfonates in solutions alkaline to the protein isoelectric point. In mixtures containing relatively large amounts of native protein, detergent combines with a maximum of 3 times its weight of protein, leaving the excess native albumin free. When heat-denatured protein is mixed in large amounts with detergent, there is complete combination in all ratios. Complexes formed in solutions containing a large amount of detergent have a correspondingly high detergent content; however, some of this detergent is reversibly bound, since dissociation of the detergent from the complex occurs during electrophoresis. This phenomenon occurs in complexes formed by mixing with either native or denatured albumin. The protein-detergent complex exhibits an electrophoretic mobility, within limits, that is parallel to the composition of the complex. Protein in the complex exhibits the electrophoretic behavior of completely denatured protein, when the fraction of detergent present is 0.3 or more.

- R. C. Merrill, Jr. Determining the mechanical stability of emulsions--a rapid quantitative method. *Indus. and Engin. Chem., Analyt. Ed.* 15(12):743-746. Dec., 1943. This paper reports the development of a method for determining the resistance of emulsions to breaking under the mechanical stress of centrifugal force. This method involves measuring the rate of separation of internal phase under a constant centrifugal force. The reciprocal of the initial rate of separation at a constant centrifuge speed has been taken as a quantitative index of the mechanical stability of the emulsion. The method has been applied to both water-in-oil and oil-in-water emulsions stabilized by lecithin, soaps, and vegetable gums. It gives results in a few hours apparently comparable to those obtained by more tedious methods involving other factors and requiring measurements over many months. Definite effects of the age of the emulsion on its mechanical stability as determined by this method have been found in the case of soap and saponin-stabilized emulsions.
- #R. C. Merrill and M. Weeks. Kinetics of the deesterification of pectin. *Jour. Phys. Chem.* 50(2):75-87. March, 1946. Interest among research workers and manufacturers in pectin solutions as colloid stabilizing, emulsifying, and gelling agents, and for pharmaceutical and other uses made it desirable to obtain data on their stability under varying conditions of pectin and added salt concentration, temperature, and pH. This paper summarizes work on the rates of deesterification of one-percent solutions of purified citrus and apple pectins and of a commercial citrus pectin at 70°, 80°, 90° and 100° C., and on the influence of added acid, base, and salts. The deesterification is a first-order reaction with respect to pectin concentration and is catalyzed by acids and bases. The rate of deesterification is a minimum at approximately the natural pH of 4. Addition of most neutral salts to pectin solutions lowers the pH and increases the deesterification rate. The influence of added salts on deesterification rate is due mainly to their effect on pH, but some specific ion effects are found. Effective ionic strengths of pectin solutions appear to be of the same order of magnitude as solutions of uni-univalent electrolytes of the same normality.
- H. S. Olcott. Monothioglycol. *Science* 96(2498):454. Nov., 1942. This paper presents useful data on monothioglycol, $\text{CH}_2\text{OHCH}_2\text{SH}$ (also designated thioglycol, monothioethylene glycol and beta- or 2-mercaptoethanol); the compound is a useful non-nitrogenous sulfhydryl reagent for protein investigations.
- #H. S. Owens, H. Lotzkar, T. H. Schultz, and W. D. Maclay. Shape and size of pectinic acid molecules deduced from viscometric measurements. *Jour. Amer. Chem. Soc.* 68(8):1628-1632. Aug., 1946. This paper reports viscosity behavior of various pectins in 0.155 M sodium chloride solution studied under different conditions of pH and temperature. Intrinsic viscosity values were found to decrease with rise in temperature and to be essentially independent of pH and probably independent of the methoxyl content. The intrinsic viscosity values for samples used have been calculated and related to the physical features of pectinic acid molecules. Length-to-diameter ratios calculated by means of Simha's equation varied from 53 to 165. Assuming a width of 10 Å., the length of the molecules varied from 530 to 1650 Å. Molecular weights ranged from 2.3×10^4 to 7.1×10^4 . The results indicate that pectin has a rigid, rod-like structure in aqueous salt solutions. Osmotic pressure measurements were used to calculate the number average molecular weights, which varied from 1.8×10^4 to 3.9×10^4 . The lack of agreement between these molecular weights and the viscosity and weight average molecular weights is believed to be due to the heterogeneity of the samples.

- K. J. Palmer and J. A. Galvin. The molecular structure of fibers made from native egg albumin. *Jour. Amer. Chem. Soc.* 65(11):2187-2190. Nov., 1943.

The formation of fibers from typical corpuscular proteins is of great interest because of the practical implications and also because of the additional information obtained on the structure of these proteins. The results of an X-ray diffraction study of these fibers and the relation between these results and those of other workers are reported in this paper. Fibers made from native egg albumin by a process which involves complex formation with detergent and drawing under steam are shown to be composed of parallel bundles of polypeptide chains running parallel to the fiber axis. The peptide chains have the beta-keratin configuration, as is evident from the similar appearance of the X-ray patterns obtained from the albumin fibers as compared with those obtained from well-oriented beta-keratin. The tensile strength of the synthetic pure protein fiber is shown to be dependent upon the degree of molecular orientation and reaches value of 38,000 pounds per square inch.

- *K. J. Palmer. The structure of an egg albumin-detergent complex. *Jour. Phys. Chem.* 48(1):12-21. Jan., 1944.

From the structure postulated in this study the author suggests that the polar amino acids probably alternate along the peptide chain in egg albumin. On the basis of this hypothesis it follows that if the layer structure for native egg albumin postulated by Pauling is acceptable, the layers in the native configuration are polar. By use of this model a plausible structure is postulated for the complex which forms between native egg albumin and detergent. This structure appears to account for the observed facts that the complex formed from native egg albumin never contains less than 25 percent of Naconol NRSF (whereas that formed from denatured egg albumin does), and that the complex containing 75 percent native egg albumin and 25 percent detergent can exist in equilibrium with free native protein.

- K. J. Palmer and H. Lotzkar. Oriented fibers of sodium pectate. *Jour. Amer. Chem. Soc.* 67(5):883-884. May, 1945.

This paper describes a method whereby well-oriented sodium pectate fibers can be made.

- K. J. Palmer and M. B. Hartzog. Configuration of the pyranose rings in polysaccharides. *Jour. Amer. Chem. Soc.* 67(10):1865-1866. Oct., 1945.

A comparison of the fiber identity periods determined by X-ray analysis of sodium alginate, alginic acid, sodium pectate, pectic acid, cellulose and soda cellulose II shows that its identity periods fall into four classes. This result is shown to be compatible with the assumption that the pyranose rings occur in either one of the two possible *trans* forms and that the chains have either two-fold or three-fold screw symmetry.

- K. J. Palmer and M. B. Hartzog. An X-ray diffraction investigation of sodium pectate. *Jour. Amer. Chem. Soc.* 67(12):2122-2127. Dec., 1945.

The results of an X-ray diffraction investigation of oriented sodium pectate fibers are recorded in this paper. The interpretation of these results indicates that the galacturonide chain has the configuration of a three-fold screw axis, and that the chains are arranged in closest packing. The structure has pseudo hexagonal symmetry. The identity period in the fiber direction is 13.1 Å. This fiber identity period is somewhat less than the value found for some cellulose derivatives in which the chain has the configuration of a three-fold screw axis. This difference in identity periods has been discussed in terms of molecular models. On sorption, sodium pectate in equilibrium with air at a relative humidity of 40 percent contains 18 percent water. A considerable portion of this water is located in the crystalline portion of the material. The non-uronide material (18 percent) is shown to have no detectable influence on the X-ray pattern.

- #R. M. Reeve. Structural composition of the sclereids in the integument of *Pisum sativum* L. *Amer. Jour. Bot.* 33(3):191-204. March, 1946.

Problems of texture constitute a major field of technological investigations in the commercial processing of vegetables as food. The causes of texture change in the seed coats of beans and peas intended for freezing or canning not only involve biological variables but also the effects of harvesting, handling, and processing treatments. Histochemical methods of detecting pentosans in the walls of "hemicellulosic" tissues in seed plants were developed by adaptation of reagent that yield characteristic color products of condensation with pentoses. Differentiation between lignin and pentosan reactions was accomplished. With these methods it was possible to detect the presence of pentosans in the secondary wall thickenings of the macrosclereids and the osteosclereids in the integuments of peas and lima beans. Also, color differentiation between these components and the polyuronides of the middle lamellae was obtained. The relationships of wall structure and texture to problems in commercial food preservation are briefly discussed. The tissue characteristics of texture and permeability are related to the pentosan-cellulose complex of the secondary walls in the macrosclereids. The cuticle also may affect permeability but bears little relationship to texture.

- E. Rietz and W. D. MacLay. Preparation of *D*-galacturonic acid from pectin. *Jour. Amer. Chem. Soc.* 65(6):1242. June, 1943.

Pectin is composed principally of polymers of *D*-galacturonic acid, and at present constitutes the most readily available source material for the preparation of this compound. The preparation of *D*-galacturonic acid directly from pectin instead of from pectic acid is reported in this paper. A number of commercial pectins have been used, and yields of *D*-galacturonic acid ranging from 74 to 80 percent, based on the uronic anhydride content of the pectin, are readily obtainable. Included in these were 285- and 300-grade apple pectins and 170-, 185-, and 200-grade citrus pectins with average yields of 78, 78, 80, 78, and 74 percent, respectively, of the uronic acid.

- T. M. Shaw, E. F. Jansen, and H. Lineweaver. The dielectric properties of beta-lactoglobulin in aqueous glycine solutions and in the liquid crystalline state.

Jour. Chem. Physics 12(11):439-448. Nov., 1944.

The dielectric constant ϵ' and loss factor ϵ'' of solutions of beta-lactoglobulin dissolved in aqueous 0.48, 1.5, and 2.5 molar glycine, and the dielectric constant of beta-lactoglobulin liquid crystals were measured for frequencies between 0.01 and 5.0 megacycles.

- T. M. Shaw. The surface area of a crystalline egg albumin. *Jour. Chem. Physics*, 12(9):391-392. Sept., 1944.

The adsorption of nitrogen at -183° and water vapor at 20° C. was determined for crystalline egg albumin. The data presented in this paper indicate that water is able to penetrate into the polar regions of the crystallites and that nitrogen does not. Methods of determining surface areas from adsorption data must be used with due regard for the surface available to the particular adsorbate used. In studies where the area desired is that of the organized crystallites, it must be first determined that the adsorbate is not able to penetrate the molecular lattice. Gases such as nitrogen and argon appear to satisfy this requirement in all particulars.

- *T. L. Swenson. Research on agricultural products. *Scientific Monthly* 62(6):525-537 June, 1946.

Two examples of research in the Western Regional Laboratory are used to illustrate the use of basic knowledge in the scientist's attempt to make something new and useful. The theoretical aspects of the work and the fundamental facts and theories are described. One example is essentially biochemical; the other is essentially biophysical.

Carbohydrates:

- J. F. Carson and W. D. Maclay. 1,4-anhydro-D,L-xylitol. *Jour. Amer. Chem. Soc.* 67(10):1808-1810. Oct., 1945.

In this study xylitol was dehydrated with benzene-sulfonic acid or sulfuric acid to yield a mixture of dehydration products from which a pure anhydroxylitol has been isolated in crystalline form. Anhydroxylitol was characterized by the preparation of three crystalline derivatives, the tribenzoate, tricarbanilate, and the monotrityl diacetate. By oxidation with periodic acid and sodium metaperiodate, anhydroxylitol is shown to contain a 1,4 oxygen ring and is designated as 1,4-anhydro-D,L-xylitol.

- J. F. Carson, S. W. Waisbrot, and F. T. Jones. A new form of crystalline xylitol. *Jour. Amer. Chem. Soc.* 65(9):1777. Sept., 1943.

The identity of a new form of crystalline xylitol was determined and the data presented in this paper.

Carotene:

- G. F. Bailey and H. J. Dutton. Apparent increase in carotene of carrots during process of dehydration. *Fruit Prod. Jour. and Amer. Food Mfr.* 24(5):138-142. Jan., 1945. When it was found that the carotene content of carrots apparently increased during the dehydration process, suspicion was cast on the reliability of the analytical method. Critical chromatographic and spectrophotometric examination of the carotene isolated in the analytical procedure revealed no new pigments or alteration of the absorption spectrum of the original carotene as a result of blanching and dehydration. No evidence could be found for significant destruction of carotene during the analytical procedure by an enzyme present in the material but inactivated by blanching. It was shown, however, that the observed apparent increase in carotene content is not a function of a systematic error in the carotene determination but is primarily a direct result of the loss of soluble solids during processing.

- *G. F. Bailey, H. J. Dutton, A. M. Ambrose, R. H. Wilson, and F. DeEds. The content and biological availability of carotene in dehydrated carrots stored at high temperatures. *Arch. Biochem.* 10(1):125-130. May, 1946.

Dehydrated carrots stored at 98° F. and 120° F. in an atmosphere of CO₂ were changed so as to be unacceptable from an aesthetic and organoleptic point of view, but carotene content was not lowered at 120° F. as much as during storage at 98° F. or lower. That the partial destruction of the carrots at the elevated temperature created conditions unfavorable to the oxidation of carotene is suggested. Spectrophotometric analysis and bioassay of extracts of these products agreed well. However, when the solid material was used for bioassay, less than one-third of the carotene present was available to the rat.

- *E. Bickoff and K. T. Williams. Determination of carotene in vegetable oils without saponification. *Indus. and Engin. Chem., Analyt. Ed.* 15(4):266-268. Apr., 1943. A rapid method is described for the determination of carotene in vegetable oil solutions without saponification. The colored oxidation products of carotene that develop during storage are removed by this method. The carotene is separated from the other chromogens by passing a petroleum ether solution of the oil

containing the mixed chromogens through a Tswett column of aluminum oxide and eluting the carotene with 2 percent acetone in petroleum ether. The method will also separate carotene from the pigments extracted by petroleum ether (30° to 60°C from dehydrated alfalfa, as well as from very large amounts of xanthophyll. The volume of sample and eluent must be controlled to ensure accurate separations of carotene by the column of aluminum oxide prepared as described.

- E. Bickoff and K. T. Williams. Stability of carotene added to solid carriers. *Indus and Engin. Chem.* 36(4):320-323, Apr., 1944.

This paper reports that the addition of carotene solutions to dry carriers in pellet form results in a very rapid loss of carotene. With protective measures, such as the addition of certain oils and of very small amounts of hydroquinone or diphenylamine as antioxidants, the retention of carotene is greatly improved. This suggests that pelleted mixtures containing extracted carotene may prove feasible as a supplementary feed.

- E. Bickoff, K. T. Williams, and M. Sparks. Stabilization of carotene with nordihydroguaiaretic acid and other antioxidants. *Oil and Soap* 22(5):126-131, May, 1945.

Edible oils fortified with carotene can be of value in supplementing our present supply of vitamin A. Fortification, however, necessitates attention to stabilization, since carotene may be readily lost by oxidation. Although added antioxidants have long been successfully employed to protect carotene in inert organic solvents, their value in edible oil solutions of carotene has not been well established. Relative values for the carotene-stabilizing effects on edible oil solutions of several antioxidants, alone and in various combinations, have been determined and are presented in this paper. One of the more promising is nordihydroguaiaretic acid. When this antioxidant is used with phospholipid or citric acid, its effectiveness is enhanced. Addition of alpha-tocopherol to oils containing only traces of this antioxidant causes a significant increase in carotene stability, and its sparing effect on carotene *in vivo* would further add to the desirability of its use in such oil solutions of carotene. In refined cottonseed oil, carotene destruction occurred concurrently with the accumulation of peroxides. In the more saturated oils, carotene destruction occurred before much peroxide was detected in the oils.

- E. Bickoff and K. T. Williams. Stability of carotene at elevated and room temperatures. *Oil and Soap* 23(3):65-68, March, 1946.

This paper is essentially an evaluation of the elevated temperature test used for carotene stability studies in this Laboratory. Stability of carotene in edible oils containing various added antioxidants was determined by storage at 25° C. and in some cases 40° C. and compared with stability as determined by the accelerated test at 75° C. Results obtained at 75° C. were in agreement with those obtained at 40° and 25° C. With most of the better antioxidants protection at the lower temperature was better than that indicated by the rapid test. Solutions of carotene in edible oils, which ordinarily might lose a significant amount of carotene in a week or less at 25° C., can be protected by addition of antioxidants for periods well over a year without such special precautions as refrigeration or storage under nitrogen or in evacuated containers. Effectiveness of nordihydroguaiaretic acid as an antioxidant for carotene was confirmed by room-temperature storage tests.

- E. J. Hoffman, F. G. Lum, and A. L. Pitman. Retention of carotene in alfalfa stored in atmospheres of low oxygen content. *Jour. Agr. Res.* 71(8):361-373, Oct., 1941. Partly because of its relatively high carotene content, alfalfa is of exceptional value in animal nutrition. A means of preserving the carotene of alfalfa in storage would profit livestock growers and extend the market for alfalfa meal.

This paper reports that storage of alfalfa meal at 40° C. in closed containers in contact with atmospheres of low oxygen content results in a high degree of carotene conservation. Presence of carbon dioxide in these atmospheres had little effect. Conservation of carotene was due in large measure to reduction in the original oxygen concentration by oxidation of constituents of the alfalfa other than carotene in early stages of storage. The most effective conservation of carotene in alfalfa commercially by means of inert gas would be by the highest possible exclusion of air throughout the storage period. The extent to which oxygen can be excluded from the storage atmosphere economically in commercial practice remains to be investigated. The permissible oxygen content of the storage atmosphere at the beginning will be somewhat less than 3 percent.

- K. T. Williams, E. Bickoff, and W. Van Sandt. Carotene. I. Preliminary report, on diphenylamine as a stabilizer for carotene. *Science* 97(2508):96-98. Jan., 1943.

A preliminary investigation has been made to determine the stabilizing effect of about 100 substances of antioxidant character on carotene. In these tests it was found that diphenylamine had the greatest stabilizing effect. It must be known from adequate tests that a substance is harmless when ingested by animals before it can be used in food or feed. Since such information is not yet available for diphenylamine, it is not safe to make any practical application of the results of this study.

- *K. T. Williams, E. Bickoff, and B. Lowrimore. Effect of antioxidants, individually and in combination, on stability of carotene in cottonseed oil. *Oil and Soap* 2 (6):161-164. June, 1944.

By an accelerated test, 1-ascorbyl palmitate, alpha-tocopherol, hydroquinone, and phospholipids from cottonseed and soybean oil have been evaluated singly and in combinations, for their antioxidant effect on carotene added to mineral oil and cottonseed oil. Their effects in retarding the formation of peroxides in the refined cottonseed oil were also determined.

- *R. H. Wilson, A. M. Ambrose, F. DeEds, H. J. Dutton, and G. F. Bailey. The content and biological availability of carotene in raw and dehydrated carrots and other vegetables. *Arch. Biochem.* 10(1):131-140. May, 1946.

That the chemical and the bioassay methods for determining carotene content do agree, due to the inability of the test animal to absorb all of the carotene in the supplement, is the conclusion arrived at in this report of tests undertaken to compare these two methods. When the carotene which is poorly utilized in the dry product is extracted and fed in cottonseed oil, the rat can use it. If knowledge of the carotene content of a sample is wanted, chemical assay would be the method of choice. If utilization of that carotene is the important question, chemical analysis may not give a true answer and the biological assay would be preferable. The two methods agree as well as can be expected when applied to raw carrots, although the results are somewhat inconclusive in two of the four experiments. The carotene of dehydrated carrots is not always fully available to the albino rat. Storage of dehydrated carrots leads to a gradual loss of carotene content as judged by both chemical analysis and biological assay. Of the other dehydrated vegetables studied, there was substantial agreement between the two methods of assay for carotene, indicating that the rat can utilize this carotene. The one exception was corn, where utilization was poor.

Enzymes:

- #G. Alderton and H. L. Fevold. Direct crystallization of lysozyme from egg white and some crystalline salts of lysozyme. *Jour. Biol. Chem.* 164(1):1-5. July, 1946.
Lysozyme has been crystallized as the salt of several acids. In addition it has been crystallized directly from egg white by a method which markedly facilitates isolation in pure form. Lysozyme crystallized over the pH range of 3 to 11 from 5 percent sodium chloride solutions yields two distinct crystal forms below pH 7.0 and the other at basic reactions. The chloride, bromide, iodide, nitrate, and carbonate of lysozyme were prepared in crystalline form. A method of crystallizing lysozyme from egg white directly is described. Yields of 60 to 80 percent were obtained.
- G. Alderton, J. C. Lewis, and H. L. Fevold. The relationship of lysozyme, biotin, and avidin. *Science* 10(2615):151-152. Feb., 1945.
On the basis of common source and certain similarities in chemical and biological properties, it has been suggested that lysozyme is identical with biotin-saturated avidin. No evidence was obtained from experiments in this Laboratory that either avidin or biotin is involved in the lytic activity generally ascribed to lysozyme.
- *G. Alderton, W. H. Ward, and H. L. Fevold. Isolation of lysozyme from egg white. *Jour. Biol. Chem.* 157(1):43-58. Jan., 1945.
A method for the isolation of lysozyme from egg white, in high yield and in essentially pure form, is described in this paper. The method depends on the (a) adsorption of lysozyme on bentonite (a montmorillonite clay), (b) elution of inactive contaminating proteins from the clay by successive washings with phosphate buffer (pH 7 to 8) and 5 percent aqueous pyridine, and (c) elution of the active material with pyridine-sulfuric acid solution at pH 5.0. The eluate is dialyzed and dried in the frozen state. A white powder is obtained containing 85 to 90 percent of the lysozyme contained in the egg white. The product was crystallized, its isoelectric point and basic character were determined, and its homogeneity proved by electrophoretic measurements.
- L. Kline, L. R. MacDonnell, and H. Lineweaver. Bacterial proteinase from waste asparagus butts. *Indus. and Engin. Chem.* 36(12):1152-1159. Dec., 1944.
The press juice from waste asparagus butts and trimmings has potential value as a constituent of industrial microbiological media. This paper describes the use of this juice for one process, the production of bacterial proteinase. Reproducible yields of proteinase were obtained on asparagus juice media by controlling the pH and the concentrations of calcium, carbohydrate, nitrogen, and phosphate, and by exercising care with regard to culture technique. The culture filtrates, containing the proteolytic enzymes, were comparable with those obtained in commercial practice. Proteinaceous press cakes from oil seeds and carbohydrates, major raw material for commercial media, may be largely replaced by asparagus-butt juice.
- H. Lineweaver and T. L. Swenson. Enzyme action in slaughtered meat animals. *Proc. Ann. Meet. Amer. Inst. Refrig.* pp. 94-103. 1941.
During chilling, the major enzyme-catalyzed change is the formation of lactic acid. This process, generally complete in one day, is due to depletion of the substrate, glycogen. The resulting lower pH, however, favors the deleterious rancidity (lipoxidase) changes, as well as the proteolytic (cathepsin) changes, which by no means reach completion during chilling. During aging chemical changes occur in the proteins of beef and lamb that apparently involve cathepsin and other enzymes acting on peptide bonds or on amino acids. However, physical changes, which presumably are not connected with enzyme action, also occur. During storage changes due to enzymes are continuations of those occurring during aging.

Rancidity enzymes are apparently more important in pork products than in beef and lamb. The effect of freezing meat on the constituent enzyme action is almost certainly of two types; one is the usual lowering of the rate of action due to reduction in temperature required for freezing; the other is a lowering of the rate of action due to immobilization or limitation of diffusion by freezing.

- H. Lineweaver and G. A. Ballou. The effect of cations on the activity of alfalfa pectinesterase. *Arch. Biochem.* 6(3):373-387. May, 1945.

This paper presents data to show that activity of pectinesterase at pH 5.7 is about 30 times as great in the presence of 0.2 M monovalent cations or 0.02 M divalent cations as in the absence of cations, but at pH 8.5 these concentrations of cations are practically without effect on the activity. The enzyme, only slightly inhibited by sodium pectate at pH 8.5, is markedly inhibited at pH 5. in the absence but not in the presence of cations. The enzyme-substrate dissociation constant at pH 5.7 is about the same (0.04 percent) at 0.025 and 0.2 M Na ion. The enzyme is adsorbed on celite near pH 5 and is eluted in dilute salt solution. The hypothesis correlating these observations is based on the assumptions, (a) that cations prevent inhibition by the pectin carboxyl groups by forming cation-carboxyl complexes, and (b) that the form of the enzyme existing in alkaline solutions has a decreased tendency to form an inactive complex with the carboxyl groups.

- *H. Lineweaver and G. A. Ballou. Properties of alfalfa pectinesterase (pectase). (Abstract). *Fed. Amer. Soc. Expt. Biol. Proc.* 2:66. 1945. (See above article).

- *H. Lineweaver and E. F. Jansen. Non-proteolytic, non-oxidative enzymes. *Ann. Rev. Biochem.* 14:69-90. 1945.

Sixteen of the nonproteolytic, nonoxidative enzymes are considered in this review of the year's work (1944) on these enzymes. *In vitro* properties are given special attention. Amidases, esterases, glycosidases, and miscellaneous enzymes including lysozyme, are reported and advances noted.

- L. R. MacDonnell, E. F. Jansen, and H. Lineweaver. The properties of orange pectinesterase. *Arch. Biochem.* 6(3):389-401. May, 1945.

Orange pectinesterase was investigated because orange rind is a potentially cheap source of the enzyme, and because pectinesterase preparations from oranges, unlike those from tomatoes and some other sources of pectinesterase, were found to be free of polygalacturonase. The data presented show that pectinesterase in citrus fruit tissues is associated with the solid particles. The increased activity caused by cations was dependent on the pH of the reaction mixture and varied from 5-fold at pH 7.5 to more than 100-fold at pH 5. Salt not only affected the activity of orange pectinesterase but also affected the extraction, adsorption, and elution and stability of the enzyme. The enzyme was inactivated slowly at 40° C. in the presence or absence of salt (pH 7.5) and lost about two-thirds of its activity in five minutes at 56° C. No polygalacturonase could be detected in extracts of orange flavedo by measurement of either reducing values or molecular weight.

- H. J. Morris, C. A. Weast, and H. Lineweaver. Seasonal variation in the enzyme content of eleven varieties of carrots. *The Bot. Gazette* 107(3):362-372. March, 1946.

Inequalities of enzyme concentration in tissues of different species of plants, as well as in the same species at different stages of maturity, are well recognized. To study this phenomenon two harvests (2 months apart) were made of eleven varieties of carrots planted in August and in March. Carrots were of prime quality when harvested. Peeled portions were assayed for catalase, peroxidase,

ascorbic-acid oxidase, and for those planted in March also for phosphatase. Activities per gram of peeled tissue were about the same as for the whole carrot root, except for peroxidase, which in samples tested was concentrated in the peel. Except for peroxidase, which varied little in average activity for all varieties, highest activities were found for carrots harvested in September, March, and January. Highest average enzyme activities were thus obtained under the most favorable growing conditions of temperature and photoperiod. Differences in average enzyme activity appeared to reflect differences in growing condition rather than in age of the carrots (within the limits of the physiological age studied). Within single harvest differences in enzyme content attributable to variety ranged from 1.2-fold for phosphatase to 3.3-fold for ascorbic-acid oxidase, and averaged about 2-fold for the four enzymes studied. Ratios of the average enzyme contents for July (best growing condition) and January (poorest growing condition) harvests were 1.3 for peroxidase, 1.7 for catalase, and 5.5 for ascorbic-acid oxidase.

- H. S. Owens, R. M. McCready, and W. D. Maclay. Enzymic preparation and extraction of pectinic acids. *Indus. and Engin. Chem.* 36(10):936-938. Oct., 1944.

Although pectin has been known for 120 years, only recently have serious attempts been made to prepare derivatives for other purposes than gelling agents. Activity has been stimulated by the fact that low-methoxyl pectins are showing considerable promise in certain fields. The presence of a pectin esterase in citrus fruit peel has made it possible to develop an efficient procedure for the manufacture of a series of pectinic acids employing the enzyme *in situ*. The partially deesterified pectins extracted from the raw material form very viscous solutions indicative of long-chain molecules. Such materials, which differ from pectic materials now available commercially, may find wide usage wherever water-soluble oil-repelling films are desired. Various salts differ in solubility characteristics and offer other possibilities for use. The conditions for the preparation of a series of pectic substances are described and several uses suggested.

- T. L. Swenson and H. Humfeld. Production of active and inactive catalase by *Proteus vulgaris*. *Jour. Agr. Res.* 65(8):391-403. Oct., 1942.

The existence of catalase in an inactive state has long been recognized. From data presented in this paper the following conclusions seem warranted: *Proteus vulgaris* produces catalase during all its growth, except in the lag phase. *Proteus vulgaris* produces two forms of catalase, active and activable. The activable form can be changed to the active form by an activator. Kolmer's cholesterinized antigen, used as an activator, produced approximately a four-fold increase in active catalase. The activable form of catalase cannot be extracted by acetone and therefore may be regarded as an integral part of the living cell--that is, a desmoenzyme. When the viable cells were destroyed, the activable catalase was either destroyed or could not be activated in the absence of viable cells.

Fats and Oils:

- J. F. Carson and W. D. Maclay. Xylitol esters of fatty acids. *Jour. Amer. Chem. Soc.* 66(9):1609-1610. Sept., 1944.

A series of fatty acid esters of the pentahydric alcohol, xylitol, was prepared in connection with a study of plasticizers. The physical and chemical constants of the xylitol esters were studied and the data are presented in this paper.

- D. F. Houston. Tris-(hydroxymethyl)-phosphine oxide trilaurate. *Jour. Amer. Chem. Soc.* 68(5):914. May, 1946.

Tetra-(hydroxymethyl)-phosphonium chloride formed by the action of phosphine on a solution of hydrogen chloride and formaldehyde was converted to tris-(hydroxymethyl)-phosphine oxide by means of barium carbonate. The crystallized product is soluble readily in benzene or chloroform, moderately in ether, and slightly in petroleum ether or methanol. It is insoluble in water.

- *E. B. Kester and G. R. Van Atta. Minor oil-bearing crops of the United States. *Oil and Soap* 19(7):119-125. July, 1942.

In this paper the subject of lesser known and little used vegetable oils, which may or may not be byproducts of crops grown in considerable abundance, is treated.

- E. B. Kester, C. J. Gaiser, and M. E. Lazar. Glycidyl esters of aliphatic acids *Journal of Organic Chem.* 8(6):550-556. Nov., 1943.

The preparation of glycidyl esters of lauric, myristic, palmitic, stearic, oleic and sebacic acids, and of the mixed fatty acids of babassu oil, castor oil, walnut oil, soybean oil, and rosin, by reacting anhydrous alkali salts of these acids with epichlorohydrin, is described. Included also are a preparation of beta-methylglycidyl myristate from beta-methylepichlorohydrin, and glycidyl palmitate and glycidyl sebacate by reacting acid chlorides with glycidol. Physical constants of the products are reported. The glycidyl esters are potential plasticizers and modifiers of vinyl resins.

- R. C. Merrill, Jr. and F. T. Moffett. Foaming properties of soap solutions. *Oil and Soap* 21(6):170-175. June, 1944.

Soaps and detergents are often appraised by the volume and stability of the suds produced. This paper reports results, obtained by the "liquid drainage" method and a modified "foam time" method, on the stability of foams from solutions of soaps and detergents. The two methods gave qualitatively equivalent results. Rates of drainage of liquid from soap and detergent foams were not proportional to the volumes of liquid in the foam. The stabilities of foams from 0.1 percent solutions of soaps of most of the natural fats and oils tested were much greater than those of foams from single soaps that were sufficiently soluble to form solutions of this concentration. The foam time of a mixture of equal volumes of two 0.1 percent solutions. A number of electrolytes, organic liquids, pectic materials, and vegetable gums greatly increased foam stability. Data on 0.03 percent sodium tallow and palm oil soap solutions indicated a maximum foam time at a pH of about 10.6. Increasing the concentrations of ten soaps from 0.05 to 0.1 percent more than doubled the foam time.

- G. R. Van Atta and W. C. Dietrich. Valencia orange-seed oil. *Oil and Soap* 21(1):19-22. Jan., 1944.

Expansion in the citrus industry in recent years calls attention to citrus seed as a potential though very minor oil source. California Valencia orange seeds contain a fairly high percentage of oil, the recovery of which by conventional methods of pressing appears to present no unusual problems. When refined, bleached, and deodorized, the oil would be quite acceptable as a food oil. It contains a very small proportion of linolenic acid but is otherwise similar to other seed oils of like iodine value.

Glutamic Acid:

- H. S. Olcott. A method for the determination of glutamic acid in proteins. *Jour. Bio Chem.* 153(1):71-82. Apr., 1944.

The method reported in this paper is based on the fact that glutamic acid can be converted to pyrrolidonecarboxylic acid under conditions which do not affect other amino acids, except cystine and cysteine. The corresponding decrease in amino nitrogen, corrected for cystine, can be used to estimate the amount of glutamic acid in protein hydrolysates. By the use of the Van Slyke manometric apparatus, the method is applicable to the determination of glutamic acid in 25 to 100 mg. samples of protein with an estimated accuracy of 5 percent. The glutamic acid is approximately 92 percent converted in 4 hours. Of a number of amino acids investigated only cystine interferes. The glutamic acid content of a number of

proteins was determined; most results agreed with previous reports. Insulin contained approximately 20 percent of glutamic acid, gelatin 12 percent, glutenin 36 percent, chicken feathers 12 percent, cottonseed globulin 20 percent, and tobacco mosaic virus 17 percent.

Gluten:

- H. S. Olcott, L. A. Sapirstein, and M. J. Blish. Stability of wheat gluten dispersions toward reducing agents in the presence and absence of a gluten proteinase. *Cereal Chem.* 20(1):87-97. Jan., 1943.

As part of a program of wheat protein research in this Laboratory, methods for obtaining stable gluten dispersions were required in order to ensure against alterations of proteins during extended time periods that might be involved in fractionation operations. Gluten dispersions in dilute acetic acid may be stabilized by heating for 5 to 10 minutes at 100° C. The solubility characteristics of gluten proteins are not appreciably altered, but an enzyme (proteinase) responsible for instability is destroyed. Proteinase is inactivated or inhibited in 10 percent sodium salicylate but activity is restored and proteinase-induced hydrolysis continues if salicylate is removed. Reducing agents increase enzymatic hydrolysis slightly but drastically reduce the viscosity of gluten freed from enzyme activity by heat or by the presence of 10 percent sodium salicylate. That the primary effect of reducing agents on gluteins is a chemical one upon the proteins and only secondarily that of enzyme activation is the conclusion reached in this study, and it is suggested that a similar explanation may be applied to the effect of reducing agents, but not necessarily oxidizing agents, on doughs.

- H. S. Olcott and M. J. Blish. Wheat gluten as an industrial protein. *Amer. Assoc. Cereal Chem. Trans.* 2(2):20-25. Jan., 1944.

The investigation of wheat gluten as an industrial protein has comprised detailed studies of means of preparation, physical and chemical properties, separation and identification of individual constituents, preparation and properties of modified gluteins and derivatives, and all possible industrial uses. With the advent of war, the activities were shifted toward more direct participation in the war effort, and at the time of writing this paper the only problems investigated were those having a bearing on war needs. The purpose was to review some of the information accumulated regarding the properties and possible uses of gluten. If and when our national economy requires more protein, wheat gluten can be used, since there is a potentially huge reservoir of raw material from which it may be drawn.

- H. S. Olcott. Outlook for wheat gluten as an industrial material. *Food Indus.* 16(7):541, 576-578. July, 1944.

In this paper the overall picture is given--source of supply, methods of manufacture, properties and potential industrial uses. The possibilities of wheat gluten as a food material are shown to be greatly dependent upon the economics of its supply. Wheat gluten, a standard but limited article of commerce for several decades has long been used in special diabetic foods. Its chief use in recent years has been as a source of monosodium glutamate, a much sought-for flavoring or condiment, particularly for soups. Within the past ten months the possibility of gluten recovery on a large scale as a byproduct from other industrial processes has received much attention.

- *H. C. Reitz, R. E. Ferrel, and H. S. Olcott. Gel-forming derivatives of wheat gluten. *Indus. and Engin. Chem.* 36(12):1149-1151. Dec., 1944.

A product obtained from wheat gluten by the action of chlorosulfonic acid and pyridine or cold concentrated sulfuric acid possesses, after neutralization, the property of absorbing rapidly one hundred to three hundred times its weight of

cold water to form a firm, odorless, tasteless, and nontoxic gel. The use of gluten sulfate as a substitute for scarce natural gums in therapeutic jellies, ointments, and other pharmaceutical preparations, and as a thickening agent or emulsifying agent in ice cream or other foods, is suggested. The material has already been used in surgery for the absorption of postoperative drainage.

Pectin:

- J. F. Carson and W. D. Maclay. The acylation of pectin. *Jour. Amer. Chem. Soc.* 67 (5):787-799, May, 1945.

This paper describes a technique for the esterification of pectin. Pectin diacetate, dipropionate and dibutyrate were prepared by esterification of citrus pectin with the acid anhydride in pyridine. Lauroyl, myristoyl, palmitoyl, and benzoylesters of citrus pectin were prepared by esterification of pectin with the corresponding acid chloride in pyridine; the degree of esterification attained varied from 1.2 to 1.6 acid groups per anhydrogalacturonic acid unit.

- E. F. Janaen, S. W. Waisbrot, and E. Rietz. Errors in the Zeisel methoxyl values for pectin due to retained alcohol. *Indus. and Engin. Chem.* 16(8):523, 526, Aug., 1944.

Errors due to retained alcohol should be guarded against, particularly in studies of pectin structure, since most frequently pectin and its derivatives are precipitated from solution with ethanol, and ordinary drying technique does not remove all the alcohol. This paper presents data to show that retained ethanol causes the methoxyl content of pectins, as measured by the Zeisel method, to be as much as 20 percent higher than saponification values. This ethanol cannot be removed by the usual drying techniques but can be removed by humidification followed by drying. Acetone rather than ethanol precipitation results in good agreement between the two methods of analysis. Retained isopropyl alcohol can be removed by drying at 100° C.

- E. F. Janaen and L. R. MacDonnell. Influence of methoxyl content of pectic substances on the action of polygalacturonase. *Arch. Biochem.* 8(1):97-112, Oct., 1945. Pectinase is that group of pectic enzymes, mainly of microbial origin, which hydrolyze pectin and pectic acid into reducing sugars and other simpler substances. This paper reports data to show that pectinase complex hydrolyzed pectic acid, prepared with either pectinesterase or alkali, at an initial rate 17 times faster than it hydrolyzed pectin. Only the de-esterified portions of pectic substances were susceptible to the action of polygalacturonase. Extent of hydrolysis of pectic substances was a function of the degree of de-esterification. Enzymic hydrolysis of 2 percent of the glycoside bonds of any of the substrates caused 50 percent of the total viscosity change. Hydrolysis of pectic acid by polygalacturonase goes through two stages: an initial rapid stage which extends up to approximately 45 to 50 percent hydrolysis of the glycoside bonds, followed by a slow stage in which the residual bonds are hydrolyzed. The first stage was 15 times as rapid as the second. The "half-hydrolyzed" material was not inhibitory to the hydrolysis of pectic acid. The Michaelis-Menten dissociation constant, K_m , for the first stage was less than 0.03 percent and for the second, greater than 1.0 percent. These observations suggest that the second stage was the hydrolysis of digalacturonic acid.

- E. F. Jansen, L. R. MacDonnell, and R. Jang. Simultaneous actions of polygalacturonase and pectinesterase on pectin. *Arch. Biochem.* 8(1):113-118, Oct., 1945. Polygalacturonase, acting simultaneously with pectinesterase on pectin at pH 4.0, had a favorable effect on the rate of de-esterification and on maintenance of the rate, as compared with action of pectinesterase alone. This favorable effect was probably due to the removal, by glycosidic hydrolysis, of pectic acid,

which inhibits pectinesterase. In sufficiently high concentrations pectinesterase enhanced the action of polygalacturonase on pectin to an extent that approached the rate observed on pectic acid. Higher concentrations of crude pectinesterase were inhibitory, probably because of the inert protein accompanying the esterase. No inhibition was observed with higher concentrations of purified pectinesterase. Pectinesterase of plant origin can be used to fortify the pectinase complex.

- C. R. Jeppesen, E. J. Eastmond, and H. G. Logan. Spectrographic determination of lead in pectinous materials. *Jour. Optical Soc. Amer.* 34(6):313-318. June, 1944. Investigations in this Laboratory on new and extended uses of pectin from apple pomace and citrus fruit waste have shown the need for rapid and reasonably accurate determinations of the amounts of lead in various pectinous materials. To follow the amounts of lead present in various portions of pectinous solution taken during the process of purification of the pomace extract and to determine the amount in the purified solid pectin product, a spectrographic method was used for detection and measurement of these trace amounts of lead. This paper describes the preparation of standards and samples, and outlines the spectrographic procedure.
- *C. R. Jeppesen and E. J. Eastmond. Spectrographic determination of lead in pectinous materials. (Abstract). *Bul. Amer. Phys. Soc.* 18(4):6; *Phys. Rev.* 64(5-6):188. 1943. (See above.)
- H. Lineweaver. Acceleration by electrolytes of alkali de-esterification of pectin. *Jour. Amer. Chem. Soc.* 67(8):1292-1293. Aug., 1945. The effect of sodium chloride, calcium chloride and magnesium chloride on the rate of alkaline de-esterification of pectin in aqueous solution is reported in this paper. These electrolytes, and in particular cations, have been shown to accelerate the rate of alkaline de-esterification of pectin as much as 400 percent. This acceleration contrasts with the small effect of electrolytes on the rate of hydrolysis of simple esters. The results indicate that the negatively charged carboxyl groups of pectin are close enough to the ester bonds to interact with the hydroxyl ions as they approach the ester bonds; salt decreases the interaction (repulsion). As has been found for the primary salt effect in other systems, the acceleration of de-esterification of pectin by salt reflects largely a change in the entropy of activation rather than in the energy of activation.
- *H. Lotzkar and W. D. Maclay. Pectin as an emulsifying agent. Comparative efficiencies of pectin, tragacanth, karaya, and acacia. *Indus. and Engin. Chem.* 35(12):1294-1297. Dec., 1943. In this paper pectin as an emulsifying agent is compared with gums tragacanth, karaya, and acacia in a study of aqueous emulsions of olive, cottonseed, and mineral oils under various conditions of acidity, ratio of oil to water, and concentration of agent by measurement of changes with time in the specific interfacial surface of the dispersed oil, hydrogen-ion concentration, and viscosity.
- H. Lotzkar, T. H. Schultz, H. S. Owens, and W. D. Maclay. Effect of salts on the viscosity of pectinic acid solutions. *Jour. Phys. Chem.* 50(3):200-210. May, 1946. This paper presents data on the viscosity of pectinic acids in solution of salts which are encountered in various phases of pectin technology. Explanations are offered, wherever possible, for the behaviors observed.
- W. D. Maclay, A. D. Shepherd, and H. Lotzkar. Use of pectin in pharmaceutical pastes and ointments. *Jour. Amer. Pharm. Assoc.* 33(4):113-116. April, 1944. Much attention has been given recently to the efficacy of various drugs and to the development of satisfactory washable gel- and emulsion-type bases in which to incorporate them. The use of pectin in this connection was studied, and this paper

presents the following results: Tannic acid-pectin paste and an ointment base stabilized with pectin were prepared and their general stability over a period of four months studied. Various medicaments were incorporated into the paste and base, and some incompatibilities were observed. Freezing arrested changes in the paste and base. At room temperature the pastes and bases gradually became more acidic but were stable. At 55° C. they became discolored and gelled after five months' storage. The paste and base fulfill the requirements specified by the National Research Council except when stored at 55° C. A comparison between the pectin paste and the tragacanth paste indicated that pectin and tragacanth have the same advantages and disadvantages.

R. M. McCready, H. S. Owens, and W. D. Maclay. The use of fibrous sodium pectate as a substitute for agar in bacteriological gels. *Science* 97(2523):428. May, 1943. Importation of agar ceased during the war and a substitute was needed. This paper reports the successful use of fibrous sodium pectate to take the place of agar in bacteriological gels.

R. M. McCready, H. S. Owens, and W. D. Maclay. Alkali-hydrolyzed pectins are potential industrial products. *Food Indus.* 1. 16(10):69-71, 139-140. Oct., 1944; 11. 16(11):92-94. Nov., 1944.

Research on pectinic acids lays the foundation for their commercial use in the making of salads, desserts, puddings, pie fillings, and dry dessert mixes. The characteristics of low-methoxyl pectins are comparable in some respects to gelatine and the starches. Gels prepared with the low-methoxyl pectin are palatable, smooth and firm, without rubbery or pasty consistency. Their preparation requires little time. Only a very short period of heating is required to dissolve the pectinic acid and gelation occurs rapidly on cooling without refrigeration. The fact that during preparation these pectin products remain very fluid offers an additional advantage. This pectinic acid is versatile; its properties are such that it gels with milk and also with fruit and vegetable products. Low-methoxyl pectins require a different method of evaluation. Their methoxyl content and viscosity make them suitable for use in low-sugar jellies having the correct acidity and concentration of calcium ions.

*R. M. McCready, H. S. Owens, A. D. Shepherd, and W. D. Maclay. Acidic isolation of low-ester pectinic acids. *Indus. and Engin. Chem.* 39(12):1254-1265. Dec., 1946. An acidic method for isolating pectinic acids of low methyl ester content which requires neither concentration of the pectinic acid solution nor the use of organic precipitating agents is shown to be effective. The various factors affecting the precipitability of this type of material are evaluated and a recommended procedure of isolation is presented.

R. C. Merrill and M. Weeks. The thermal degradation of pectin. *Jour. Amer. Chem. Soc.* 67(12):2244-2247. Dec., 1945.

The most obvious change when a solution of pectin is heated is the rapid irreversible decrease in viscosity, denoted in this paper by the term degradation. The large initial decrease in viscosity on heating is due mainly to the breaking of primary chemical valence bonds rather than to the destruction of a secondary aggregate. This is shown by the irreversibility of degradation, the absence of a pronounced effect of urea and temperature (up to 50°) on the viscosity of dilute pectin solutions, the fact that the loss in relative viscosity is closely associated with a decrease in the intrinsic viscosity of the pectin, and the magnitude of the value for the activation energy of the loss in viscosity with heating time (28,000 ± 6,000 cal./mole).

H. S. Owens, E. Lotzkar, R. C. Merrill, and M. Peterson. Viscosities of pectin solutions. *Jour. Amer. Chem. Soc.* 66(7):1178-1182. July, 1944.

The relative viscosity of pectin solutions varies with concentration in a manner similar to that of other ionizable hydrophilic colloids and certain salts. A tentative hypothesis is proposed to explain the results obtained.

- *H. S. Owens and W. D. Maclay. Effect of methoxyl content of pectin on the properties of high-solids gels. *Jour. Colloid Science* 1(4):313-326. July, 1946.

This paper reports an examination of pectin gels, prepared under different conditions, with respect to the modulus of rigidity, the modulus of elasticity under compression, and the breaking limit. Comparison of a high-solids gel prepared from rapid-set pectin with a high-solids gel prepared from slow-set pectin, partly de-esterified by alkali or acid, was made at different pH values and in the presence of calcium ion. A torsion-type instrument (rigidometer) was employed to obtain absolute measurements of the modulus of rigidity, a sagometer was used to measure modulus of elasticity in compression, and a Tarr-Baker plunger-type instrument served as the tester for obtaining information on the breaking limit. It was found that the modulus of rigidity of pectin gels is related to the molecular weight of the pectin and that the modulus of elasticity in compression can be related to that in shear if a Poisson ratio of 0.5 is assumed when small deformations are observed.

- T. H. Schultz, H. Lotzkar, H. S. Owens, and W. D. Maclay. Influence of method of esterification on the viscosity and acid behavior of pectinic acid solutions. *Jour. Phys. Chem.* 49(6):554-563. Nov., 1945.

Considerable interest has developed in pectinic acids (colloidal polygalacturonides, partly esterified with methyl alcohol) that have lower ester contents than those used commercially for high-solids gels. This paper reports that the viscosity-pH curves for high-methoxyl pectinic acids exhibit maxima near pH 6, while the low-methoxyl acids exhibit maxima near pH 6 and minima near pH 4. Under the conditions used, the transition from characteristics of high-methoxyl to those of low-methoxyl pectinic acids occurs at a methoxyl content above 8 percent for esterase-deesterified pectinic acids and near 6 percent for those deesterified by acid or alkali. Pectinic acids deesterified by citrus pectinesterase are weaker than those of the same methoxyl content prepared with alkali. An hypothesis based on evidence that the esterase deesterifies portions of the galacturonide chain, while acid or alkali acts in a random manner, is proposed to explain the differences observed in behavior.

- K. T. Williams and C. M. Johnson. Determination of soluble pectin and pectic acid by electrodeposition. *Indus. and Engin. Chem., Analyt. Ed.* 15(1):23-25. Jan., 1944
- Investigations designed to develop new and extended uses for pectin made desirable an analytical method capable of determining small amounts of pectin. This paper describes a new approach to the determination of pectin, wherein solutions of pectin or pectates are deashed by the use of ion-exchange resins. The pectin or pectic acid is electrolytically deposited at a platinum anode in a weighable form. The method requires less of the analyst's attention than does the calcium pectate method and, with partially purified solutions, gives results of the same order of accuracy. The method is especially applicable to amounts of pectin ranging between 5 and 50 mg.

Protein:

- *G. Alderton, W. H. Ward, and H. L. Fevold. Identification of the bacteria-inhibiting, iron-binding protein of egg white as conalbumin. *Arch. Biochem.* 11(1):9-13. Sept., 1946.

In connection with work dealing with the antibiotic, lysozyme, the authors purified the iron-binding antibiotic protein of egg white and identified it electrophoretically as 95 percent (or more) conalbumin. Approximately 80 percent of the conalbumin of egg white was isolated in this fraction. The antibacterial protein and conalbumin appear to be identical. Crystalline egg albumin, crystalline lysozyme and the globulin fraction of egg white are incapable of producing bacterial inhibition by iron deprivation.

- *G. H. Brothier, C. H. Binkley, and B. Brandon. Keratin--A modifier for phenolic plastics. *Modern Plastics* 22(7):157-160, 196, 198. March, 1945.
- This paper describes the properties and the advantages of keratin as a modifier for phenolic plastics. Readily available, low-cost, or waste keratins such as feathers, hoofs, and hair, can be used, after simple and economical treatment to modify phenolic molding powders. The modified powder can be prepared by the same method and in the same equipment as is used for the preparation of unmodified phenolic-resin molding powders. It has practically the same flow properties as general-purpose phenolics; hence it is readily adapted to standard molding procedure and equipment, but may require a somewhat longer molding cycle to insure cure. The finished molded product absorbs somewhat more water than do the molded products of most phenolics, but not enough more to be out of line. Its flexural strength is about 15 percent less than that of unmodified phenolic plastic, and its impact strength is about the same. The phenolic-keratin plastic can be produced in a wider range of colors than is practicable with the phenolics, and its arc resistance is at least two or three times as great. In addition, lower material costs would result from the replacement of a portion of phenolic resin by the lower-cost keratin.
- *D. W. Elam, H. M. Preusser, and R. L. Page. New plasticizers for vinyl resins and cellulose esters. *Modern Plastics* 20(9):95-97, 146-150. May, 1943.
- Among the plasticizers reported in this paper, two succeeded in plasticizing cellulose acetate. Xylitol penta-acetate shows excellent retention, but is unstable when exposed to water. It is a nonsolvent for cellulose acetate. Diethoxyethyl fumarate is retained below 40 percent, is fairly stable and relatively insoluble in water and is a solvent for cellulose acetate at molding temperatures. Both of these plasticizers impart good flow under molding conditions. In cellulose acetate butyrate, xylitol pentabutyrates has the desirable qualities of imparting good flow and good flexibility to the molded piece, is stable and water insoluble and is retained to a high degree. Plasticized pieces are odorless if the plasticizer content is kept below about 50 percent; at 80 percent a slight "butyric" odor can be detected. Dibutoxyethyl fumarate shows excellent stability, is water insoluble, and imparts good flow at molding temperatures.
- *H. Fraenkel-Conrat. Effect of acylating agents on the sulfhydryl groups of crystalline egg albumin. *Jour. Biol. Chem.* 152(2):385-389. Feb., 1944.
- At pH 5 to 6, phenyl isocyanate and carbon suboxide were found to react with the thiol groups in preference to the amino or phenolic groups of crystalline egg albumin. Ketene treatment caused more rapid acetylation of the amino groups than of the thiol groups. The thio esters formed by any of these reagents were hydrolyzed by alkali at room temperature, permitting almost complete recovery of the protein thiol groups. Such reversible acylation of sulfhydryl groups was also demonstrated in model experiments with cysteine and glutathione.
- H. Fraenkel-Conrat. The action of 1,2-epoxides on proteins. *Jour. Biol. Chem.* 154(1):227-238. June, 1944.
- Epoxides, such as ethylene oxide, propylene oxide, and epichlorohydrin, were found to be suitable reagents for the esterification of protein carboxyl groups in aqueous solution at room temperature. Sulfhydryl, amino, and phenolic groups also reacted. Through treatment of crystalline egg albumin and beta-lactoglobulin with these compounds, preparations of modified protein were obtained which differed from the original material in several particulars. The isoelectric point was increased from 2 to 3 pH units. In general, the newly introduced bonds were surprisingly stable in acid and alkaline solution with the exception of small proportions of the substituted carboxyl and amino groups which were hydrolyzed readily in acid and alkali, respectively.

- *H. Fraenkel-Conrat and M. Cooper. The use of dyes for the determination of acid and basic groups in proteins. *Jour. Biol. Chem.* 154(1):239-246, June, 1944. Microanalytical methods developed for the estimation of the number of acid and basic groups of proteins are reported in this paper. These were based on the tendency of the polar groups to bind dyes of the opposite charge, resulting in precipitation of the protein-dye complex. The acid dye, orange G, combined stoichiometrically with basic protein groups at pH 11.5, but the extent of combination was in this case slightly affected by other factors, such as protein concentration. The number of protein groups binding these dyes corresponded well to the total number of basic (guanidyl, imidazole, amino) and acid (carboxyl, phenol, thiol) groups of crystalline egg albumin and beta-lactoglobulin and, approximately, to those of several crude proteins studied. The proposed micromethods were applicable to both soluble and insoluble proteins. They have proved useful tools in the interpretation of the action of various chemical agents on proteins.
- H. Fraenkel-Conrat and H. S. Olcott. Esterification of fatty and amino acids with 1,2-epoxides in aqueous solution. *Jour. Amer. Chem. Soc.* 66(8):1420, Aug., 1944. Model experiments were performed in which fatty acids and amino acids were treated with ethylene oxide, 1,2-propylene oxide, or epichlorohydrin in aqueous solution or suspension at room temperature. In contrast to the carboxyl groups, the amino groups appeared to react much more readily in the uncharged state, i.e., in alkaline solution or only after all acids originally present had been "neutralized" by combination with the epoxide. Complete disappearance of the primary amino groups of 0.08 M solutions of monosodium glutamate or of alanine in the presence of sodium acetate (0.08 M) occurred within two days of treatment with excess propylene oxide (3 M). Surprisingly, the dipolar ion did not react as readily in the absence as in the presence of other electrolytes.
- H. Fraenkel-Conrat, M. Cooper, and H. S. Olcott. Action of aromatic isocyanates on proteins. *Jour. Amer. Chem. Soc.* 67(2):314-319, Feb., 1945. Aromatic isocyanates in anhydrous media are widely used for the characterization of alcohols and amines. This paper reports on the reaction of proteins when treated with aromatic isocyanates under anhydrous conditions and in the presence of pyridine. Reaction occurred with: (1) the basic groups, including amino, guanidyl, and imidazole; (2) the acid groups, including carboxyl, thiol, and phenolic; and (3) the primary amide, and probably part of the aliphatic hydroxyl groups. Under the same conditions the peptide groups of chain molecules did not react appreciably, in contrast to the simple diketopiperazines which bind two molecules of phenyl isocyanate. The method described by Plimmer for quantitative liberation of the primary amide, amino, and the guanidyl nitrogen by the action of nitrous acid in mineral acid was applied successfully to proteins. This reaction made possible estimation of the extent of interaction of amide groups with phenyl isocyanate. The products of the anhydrous reaction of phenyl isocyanate with alanine and with glycine and alanine anhydrides are described.
- H. Fraenkel-Conrat, M. Cooper, and H. S. Olcott. The reaction of formaldehyde with proteins. *Jour. Amer. Chem. Soc.* 67(6):950-954, June, 1945. The reaction of formaldehyde with proteins is of importance in a number of fields some of which are the tanning of leather, the hardening of tissues, fibers, and plastics, and the preparation of copolymers. This paper reports that in 4 percent solution, at pH 3 to 7 and 70°, formaldehyde combined with both the primary amino and the primary amide groups of proteins. In contrast to interpretations of other investigators, the secondary amide linkages of the peptide chain, and the phenolic groups, were found not to bind appreciable amounts of formaldehyde. These findings were confirmed with protein derivatives and synthetic polypeptides containing a maximal or minimal number of reactive groups. The preparation of a

polypeptide rich in primary amide groups from polyglutamic acid is described. This material bound more formaldehyde than did any of the proteins investigated.

- H. Fraenkel-Conrat and H. S. Olcott. Esterification of proteins with alcohols of low-molecular weight. *Jour. Biol. Chem.* 161(1):259-268. Nov., 1945.
Carboxyl groups of proteins and model substances are readily methylated at room temperature in methyl alcohol containing small amounts of mineral acids (0.02 to 0.1 N). The catalytic activity of acid chlorides in esterifications is due to the liberation of hydrochloric acid. The acid-catalyzed reaction of proteins with methanol appears to be a specific one involving only the carboxyl groups; amino, phenolic, thiol, and indole groups and peptide and amide bonds are unaffected. Esterification occurs also with higher primary alcohols, but is slower and progressively less complete than with methanol. Several proteins dissolve in the alcohols during the reaction.
- H. Fraenkel-Conrat and H. S. Olcott. Reaction of formaldehyde with proteins. II. Participation of the guanidyl groups and evidence of crosslinking. *Jour. Amer. Chem. Soc.* 68(1):34-37. Jan., 1946.
The reaction of formaldehyde with amino acids and proteins has received renewed attention and application in recent years. This paper reports that guanidyl groups bind formaldehyde at 70° in neutral or acid solution. Protamine sulfate and simple substituted guanidine salts bind up to 2 moles for each guanidine group; free guanidine salts up to 3 moles of formaldehyde. At room temperature the reaction proceeds slowly and to a lesser extent. The reactivity of the guanidyl nitrogen toward nitrous acid in mineral acid is decreased after combination with formaldehyde. A decrease in the basicity of the guanidyl groups is also evident. If the reaction is performed at protamine concentrations exceeding 3 percent, the product is largely water insoluble. In 1-3 percent solution and at pH 6-7, the reaction product remains soluble, but differs from untreated protamine in being in part nondialyzable. Osmotic pressure measurements indicate a considerable increase in the average molecular weight of these treated preparations. This is regarded as evidence for intermolecular condensation through crosslinking methylene groups.
- *A. A. Klose, Barbara Hill, and H. L. Revold. Presence of a growth-inhibiting substance in raw soybeans. *Proc. Soc. Expt. Biol. and Med.* 62(1):10-12. May, 1946.
The low nutritional value of raw soybean proteins and the marked improvement on heating have been recognized for some time; however, the fundamental mechanism by which this change takes place has not been satisfactorily explained. The experimentally demonstrated effect of heating is to make the methionine of the protein nutritionally available. A substance which inhibits the growth-promoting properties of proteins in rats is present in raw soybeans. The substance is nondialyzable, precipitated by salt, and inactivated by heat. It appears, therefore, to be a protein, which has been shown to be concentrated in the acid-soluble (pH 4.2) fraction of the soybean protein. These results are in agreement with those presented by Ham, Sandstedt, and Mussehl for the chick.
- C. B. Jones and D. K. Mecham. The dispersion of keratins. I. Studies on the dispersion and degradation of certain keratins by sodium sulfide. *Arch. Biochem.* 2(2) 209-223. June, 1943.
Keratin materials, such as feathers, hoofs, and horns, are available in large quantities and possess several properties that suggest suitability for utilitarian purposes. Among these properties are fibrous or horny texture, elasticity, high tensile strength, and a marked resistance to chemical and bacterial attack. However, the general insolubility of keratins in comparison with most other proteins is a serious handicap in certain types of industrial utilization. The

effects of temperature, time, Na_2S concentration, and ratio of keratin to Na_2S upon the extent of dispersion of feather keratin in Na_2S solutions and upon the yield of material obtained by acidification of such dispersions are reported in this paper. The following combination of the above factors was found to yield maximal dispersion of feather keratin with minimal degradation of the dispersed protein; digestion with 0.1 M Na_2S (100 ml. of solution per 7.5 g. of keratin) for about 2 hours at 30°C. The dispersed protein was recovered nearly quantitatively by acidification of the dispersion to pH 4.2. Feather keratin is more readily dispersed and less stable in solutions of Na_2S than are the keratins of hoof, hog hair, and wool.

- C. B. Jones and D. K. Mecham. The dispersion of keratins. II. Studies on the dispersion of keratins by reduction in neutral solutions of protein denaturants. *Arch. Biochem.* 3(2):193-202. Dec., 1943.

In this study of the dispersion of certain keratins in alkaline solutions of sodium sulfide it was found possible to suppress protein degradation to such an extent that the dispersed proteins could be recovered nearly quantitatively by acid precipitation. Keratins can be dispersed at neutral reaction by cleavage of their disulfide bonds, either by reduction with sulfhydryl compounds or by the action of bisulfite, in the presence of any of a number of substances (urea, guanidine, a synthetic detergent, and others) which act upon non-keratin proteins as denaturants. The dispersibility of one keratin may differ from that of another in a particular combination of dispersing and disulfide-splitting agents and may vary with different combinations of these agents. Of the keratins investigated, feather keratin is most readily dispersed in neutral solutions, and ovokeratin is unique in its resistance to dispersion not only in neutral solutions but also in alkaline reducing solutions.

- H. P. Lundgren. The formation of fibers from non-fibrous native proteins. *Jour. Amer. Chem. Soc.* 63(10):2854-2855. 1941.

This note concerns the use of detergents by means of which it has been found possible to control the transformation of the native forms into the unfolded configuration of all the non-fibrous proteins so far tested in this Laboratory. This change was followed in two ways: by the ability to draw fibers from the precipitated protein, and by the corresponding viscosity changes in the system protein-detergent. Elastic and highly double-refracting fibers were obtained in this manner from the following proteins: crystalline egg albumin, purified preparations of hog thyroglobulin, wheat glutenin, casein, and commercial preparations of zein and blood albumin. Detergents appear to be superior to other reagents which have been investigated, although some, including pyrogalllic acid and guanidine hydrochloride, were found to behave somewhat similarly. The conditions favorable for the drawing of fibers appear to vary with the protein, the nature and concentration of the reagent, the temperature and the pH of the system.

- H. P. Lundgren and R. A. O'Connell. Artificial fibers from corpuscular and fibrous proteins. *Indus. and Engin. Chem.* 36(4):379-374. April, 1944.

Proteins in general are potential fiber-building material. By proper manipulation of proteins derived from surplus and waste agricultural and industrial commodities fibers have been made with molecular orientation, strength, and moisture-absorbing characteristics comparable with those of natural protein fibers. These fibers have been made with dispersing agents which are mild in comparison with those commonly used for commercial protein fibers. The agent (a detergent) used not only serves as a solvent for proteins but also interacts in appropriate mixing proportions with proteins to form complexes containing unfolded protein. Solutions containing complexes of appropriate composition can be used to make fibers

either by passage through a spinneret into a coagulating bath of salt solution, or by precipitation with inorganic salt with subsequent drawing of the precipitate into a fiber. The detergent can be recovered with aqueous acetone, leaving the peptide chains in the resulting protein fibers in such a state that they can be oriented by drawing in live steam. Secondary and primary valence cross linkages then occur which hold the peptide chains in a highly oriented condition when the fiber is removed from the steam bath. As the degree of orientation in the fibers is increased, tensile strength and water resistance increase although the range of elastic deformation decreases.

- H. P. Lundgren. Synthetic protein fibers from protein-detergent complexes. *Textile Res. Jour.* 15(10):335-353. Oct., 1945.

The use of hydrocarbon salts in the preparation of spinning dispersions from copolymers as well as fibrous proteins is described. Egg-white and chicken-feather keratin were used as typical proteins. By appropriate stretching along with the removal of detergent, highly oriented fibers having the α -keratin structure typical of natural protein fibers have been made. With crystalline egg albumin as a model protein, it is shown that primary interaction between proteins and long-chain hydrocarbon salts is electrostatic, involving the basic groups of the protein when anionic detergents are used. Additional detergent can be bound, presumably by the residues of the detergent bound electrostatically and by non-polar forces. When additional detergent is bound, the complex acquires flow properties that are necessary in the fiber-making process.

- H. S. Olcott. Cystine content and enzyme digestibility of powdered hoof proteins. *Proc. Soc. Expt. Biol. and Med.* 54(2):219-220. 1943.

Considerably more than half of dried powdered cattle, horse, and hog hoof material was found to be digestible and horse hoof the least. The undigestible residue in each case contained more cystine than the original preparations. The soft part of the cattle hoof contained less cystine and was more readily digested than the horn-like front portion. Thus hoof powder consists of at least 2 & possibly a number of different kinds of proteins.

- H. S. Olcott and H. Fraenkel-Conrat. Water resistance of proteins. Improvement through chemical modification. *Indus. and Engin. Chem.* 38(1):104, 106. Jan., 1946

The use of proteins in plastics is seriously restricted by their poor water resistance. This paper is concerned primarily with experiments designed to produce protein derivatives with reduced affinity for water, through chemical reaction. Proteins were treated with a number of organic reagents and the products examined for water resistance by measurement of the uptake of water by pressed disks. Aryl and long-chain alkyl isocyanates and also aromatic acid anhydrides and chlorides proved most effective. A number of proteins yielded phenyl isocyanate derivatives showing 24-hour water absorption of 1 to 2%. Phthalic anhydride gave products of low water absorption with egg white and cattle hoof. Protein derivatives of low water absorption showed a tendency to plastic flow without the addition of water as plasticizer.

- E. F. Potter and C. B. Jones. Separation and determination of protein sulfur, sulfide sulfur, and other sulfur in sodium sulfide dispersions of keratins. *Indus. and Engin. Chem., Analyt. Ed.* 15(1):15-17. Jan., 1943.

This paper reveals that the sulfur in sodium sulfide dispersions of keratins may be separated into three parts: protein sulfur, sulfide sulfur, and other sulfur compounds by means of basic aluminum acetate. Sulfides may be separated from sulfites, thiosulfates, and sulfates, but not from bisulfites, by treatment with basic aluminum acetate.

- *H. C. Reitz, R. E. Ferrel, H. Fraenkel-Conrat, and H. S. Olcott. Action of sulfating agents on proteins and model substances. I. Concentrated sulfuric acid. *Jour. Amer. Chem. Soc.* 68(6):1024-1031. June, 1946.

The reaction of cold, concentrated sulfuric acid on proteins resulted in the approximately quantitative formation of acid sulfates of the hydroxyl groups of serine, threonine, and hydroxyproline residues. The sulfhydryl group of cysteine reacted to form the thiosulfate. Under the specific conditions used, hydroxy groups of tyrosine were not appreciably sulfated; some ring sulfonation occurred. The O-sulfuric acid esters of serine, threonine, and hydroxyproline, and S-cysteine sulfonate were prepared by the action of concentrated sulfuric acid on the amino acids. The stabilities of the protein and amino acid sulfate bonds in sulfuric acid and in dilute acid and alkaline solutions were determined.

- #H. C. Reitz, R. E. Ferrel, H. S. Olcott, and H. Fraenkel-Conrat. Action of sulfating agents on proteins and model substances. II. Pyridine-chlorosulfonic acid. *Jour. Amer. Chem. Soc.* 68(6):1031-1035. June, 1946.

Various proteins were treated with the reaction product of chlorosulfonic acid and pyridine under anhydrous conditions at 70-80° for two and one-half hours. This led to the covalent binding of considerable amounts of sulfate sulfur (up to 10%), corresponding in several proteins to the sulfation of one out of every three amino acid residues. The mode of linkage was ascertained through the use of model substances and proteins or polypeptides rich in certain groups. It was shown that, under the condition used, part or all of the aliphatic and phenolic hydroxyl, thiol, primary amide, amino, guanidyl and indole groups were transformed to sulfates or sulfamates. For most proteins, there was a definite correlation between the sum of these groups and the sulfate introduced. The imidazole and carboxyl groups and the peptide linkage did not participate in the reaction. The stability of the various sulfate linkages in acid and alkali was investigated. Sulfamates of indoles or guanidines appear not to have been described previously.

- W. H. Ward, L. M. High, and H. P. Lundgren. Physicochemical characterization of dispersed chicken feather keratin. *Jour. Polymer Res.* 1(1):22-36. Jan., 1946.

Chicken feather keratin, dispersed in a neutral aqueous solution of an alkylbenzenesulfonate with sodium bisulfite, forms with the sulfonates a stable complex, which was freed from dialyzable material. The dialyzed complex contained about three parts of protein to two of the sulfonate. The specific refractive increment of the complex was 199×10^{-5} per g. per 100 cc. ($\lambda = 539 \text{ m}\mu$); a representative value for the partial specific volume of the complex is 0.801 cc. per g. in dilute aqueous solution at 28.3° C. Electrophoresis shows two principal electrophoretically distinct species, in approximately equal quantity, having falling mobilities less than that of the free sulfonate. A representative number-average molecular weight, determined from osmotic pressure, is 57,000. The normalized diffusion gradient is symmetrical but is leptokurtic, deviating considerably from the ideal. The weight-average diffusion constant is about $6.91 \times 10^{-7} \text{ cm.}^2 \text{ per sec.}$, referred to pure water at 20° C. Gralen's ratio of the diffusion constants was found to be 1.35. The material is heterodisperse. On sedimentation analysis, the complex exhibited a single boundary having considerable spread. The average sedimentation constant, extrapolated to infinite dilution and referred to pure water at 20° C., is 5.18 Svedberg units. The average molecular weight determined from the sedimentation constant and the weight-average diffusion constant is 75,100. The computed frictional ratio $f/f_0 = 1.07$, of the complex shows that the complex is not extended in dilute solution. If the representative molecular unit is an unhydrated prolate ellipsoid of revolution, the ratio of the major to minor axis is 4 and the absolute values of the length and width of the unit are 106 Å. and 42.4 Å. The molecular weight of the keratin portion of the complex is of the order of 34,000 to 40,000, depending upon the average chosen.

Tannin:

- E. F. Potter, K. T. Williams, T. L. Swenson, and I. C. Feustel. Tannin extract from Western hemlock bark. *Indus. and Engin. Chem.* 36(12):1146-1149. Dec., 1944.
- Because our principal domestic source of tannin is being depleted by chestnut blight, there is need for the development of new domestic sources. An improved process is suggested for the preparation of tannin extract from the bark floated Western hemlock logs collected at pulping centers in the Pacific Northwest. A horn-angle hydraulic press was used to prepare the moist bark for extraction. Bark pressed in this manner required only 4 hours for leaching, and the material did not pack or channel in the experimental leaching vats; it would probably leach well in continuous countercurrent-type equipment. Solubilization, four necessary to reduce the high content of insolubles in the tannin extracts was accomplished by the action of sodium bisulfite.

Tartrates:

- J. R. Matchett, R. R. Legault, C. C. Nimmo, and G. K. Notter. Tartrates from grape wastes. Use of ion exchangers in acid-carbonate cycle. *Indus. and Engin. Chem.* 36(9):851-857. Sept., 1944.
- A substantial part of the approximately 15,000,000 pounds of tartaric acid annually required in our domestic economy and hitherto imported is potentially available in the wastes of the grape processing industry. Laboratory-scale experiments indicate the commercial feasibility of utilizing synthetic ion-exchange materials for recovery of this and possibly other valuable constituents of the wastes. Results of experiments involving a chloride-tartrate ion-exchange cycle on the anion exchanger bed thus far indicate that in this cycle the exchanger retains its efficiency longer in contact with the complex grape substance; in addition the process would require only about half the plant setup demanded by the procedure outline here. The cation exchanger would not be required. In either cycle, thorough defecation and decolorization of the influent solutions appear certain to prolong effectively the useful life of exchangers.

Techniques:

- A. A. Andersen. Recovery of agar from used media. *Jour. Bact.* 46(4):396-397. Oct., 1943.
- This paper reports a simple and satisfactory method for the recovery of agar from used culture media. The steps involved are: (1) drying, (2) grinding, (3) washing, and (4) drying.
- A. A. Andersen. A simple automatic media dispenser. *Indus. and Engin. Chem., Analy. Ed.* 17(7):463-464. July, 1945.
- The automatic dispenser described in this paper was constructed primarily for tubing bacteriological media. It is inexpensive to build, easy to repair, and operates by hand or motor. The quantities delivered are reproduced with remarkable accuracy. A new type of valve, made from a rubber stopper and described here for the first time, has many uses in the laboratory. Any liquid or gas which does not attack rubber or glass can be dispensed in the apparatus. It can be used to circulate liquids or gases in closed systems, aerate fermentations, or as a filter pump.
- #J. F. Carson and W. D. Maclay. The acylation of polyuronides with formamide as a dispersing agent. *Jour. Amer. Chem. Soc.* 69(6):1015-1017. June, 1946.
- In this paper a new technique has been described for the acylation of polyuronides, in which formamide is used as a solvent or gelatinizing agent prior to esterification with pyridine and an acid anhydride.

- H. J. Dutton and G. F. Bailey. Modification of Cenco spectrophotometer, permitting measurements of reflection and fluorescence spectra. *Indus. and Engin. Chem. Anal. Ed.* 15(4):275-277. April, 1943.

A simple modification of the Cenco spectrophotometer permits the measurement of reflection and fluorescence spectra with moderate resolution. The arrangement whereby fluorescence is observed from the same direction as the exciting light is superior to other possible arrangements, in that the shape of the curve representing the spectral distribution of energy and the position of the maximum are independent of concentration of the fluorescing substance.

- H. J. Dutton. Adsorption analysis of colorless compounds: Method and application to the resolution of stearic and oleic acids. *Jour. Phys. Chem.* 48(4):179-186. July, 1944.

This paper presents a method for the adsorption analysis of colorless compounds. The method employs a highly sensitive differential refractometer modified for measurement of changes in the refractive index of percolates from adsorption columns during continuous flow. The resolution of stearic and oleic acids has been investigated as an example of the application of this general method. Advantages and limitations of the method are discussed.

- E. J. Eastmond. A useful tool for shaping spectrographic graphite electrodes. *Jour. Optical Soc. Amer.* 34(10):621-622. Oct., 1944.

Graphite electrodes with a central post and annular ring have been used at this Laboratory in direct current arc methods of spectrographic analysis. The size of this cavity is dependent on the form of the sample under investigation and the amount found necessary to give spectra suitable for the analysis required. A tool for shaping these graphite electrodes is described in this paper.

- E. J. Eastmond. Spectrographic determination of calcium in microbiological culture media. *Jour. Optical Soc. Amer.* 36(1):57-60. Jan., 1946.

One of a series of investigations undertaken at this Laboratory regarding the utility of asparagus-butt juice as a microbiological culture medium involved the effect of various metallic constituents on mold growth and bactericide yield. In order to follow changes in metallic composition of the medium as growth progresses, fairly rapid methods of analysis were considered desirable. This paper discusses the spectrographic determination of calcium.

- #I. C. Feustel and H. Humfeld. A new laboratory fermenter for yeast production investigations. *Jour. Bact.* 52(2):229-235. Aug., 1946.

Previously described laboratory yeast fermenters have not proved entirely satisfactory, chiefly because it has been extremely difficult to obtain a sufficiently fine and uniform dispersion of air by means of the devices commonly used. This paper reports an improved laboratory fermenter for the culturing of yeast. It employs mechanical agitation for the dispersion of air, with an operating capacity of 500 to 2,000 ml.

- H. Fraenkel-Conrat. Effect of light on the Van Slyke method for the determination of amino groups. *Jour. Biol. Chem.* 148(2):453-454. May, 1943.

This paper reports that during a study of protein-aldehyde reactions, unexpected variations were obtained in amino nitrogen determinations of proteins and their derivatives by the manometric method of Van Slyke. A search for the cause indicated a correlation between these high values and the intensity of light falling upon the reaction chamber. Further experiments indicated that tyrosine and its derivatives give off extra nitrogen under the conditions of the Van Slyke analysis when the reaction chamber is illuminated.

- #D. F. Houston and W. A. Van Sandt. Analysis of binary mixtures of normal aliphatic dibasic acids and esters. Use of composition-melting-point relations of the acids. *Indus. and Engin. Chem., Analyt. Ed.* 18(9):538-540. Sept., 1946.

An empirical method is presented for determining the melting ranges of fused and quenched samples of dibasic acid mixtures. Application to binary mixtures of alternate and adjacent acids containing six to twelve carbon atoms reveals that compositions may be determined within 1 to 5 percent, depending on the composition of the sample. Approximate data on eutectic temperatures of the systems are included.

- #D. F. Houston and J. S. Furlow. Analysis of binary mixtures of normal aliphatic dibasic acids and esters. Use of refractive indices of dimethyl esters. *Indus. and Engin. Chem., Analyt. Ed.* 18(9):541-542. Sept., 1946.

Measurements on purified dimethyl esters of dibasic acids having from six to twelve carbon atoms show that their refractive indices bear linear relations to change in temperature and to weight percentage of the composition of binary mixtures. A change of 0.0001 index unit corresponds to three to six percent change in composition of the mixtures, thus approaching by a simple and rapid measurement the accuracy obtainable by saponification equivalent determinations.

- C. M. Johnson. Determination of water in dry food materials. Application of the Fischer volumetric method. *Indus. and Engin. Chem.* 17(5):312-316. May, 1945.

This paper reports that with the Fischer volumetric method it was possible to determine the moisture content of starches, sugars, pectin, and spray-dried egg powder fairly rapidly and to get results that agreed with those obtained by the standard vacuum-oven technique. The apparent moisture contents of a number of dehydrated vegetables and fruit powders when determined by electrometric titration were generally slightly higher than those obtained by the vacuum-oven method. A rapid and accurate method for the determination of water in many dried foods and food materials is necessary for the proper control of the finished product in manufacturing plants and inspection laboratories. The volumetric method is very well suited to the rapid and accurate determination of moisture in starches, sugars, pectin, and egg powders.

- *J. C. Lewis. A lactobacillus assay method for p-aminobenzoic acid. *Jour. Biol. Chem.* 146(2):441-450. Dec., 1942.

A microbiological assay method for p-aminobenzoic acid is described in this paper. The method is based on the growth factor activity of p-aminobenzoic acid for *Lactobacillus arabinosus*. Its reliability is indicated by reproducibility of assays, by agreement of assay values obtained with varying levels of added sample, and by recoveries of p-aminobenzoic acid added to various samples. The method is very sensitive, the assay range being 0.15 to 0.5 millimicrogram of p-aminobenzoic acid. Assay values for a number of biological materials are included. The occurrence of biologically inactive forms of p-aminobenzoic acid is indicated. These are activated by alkaline hydrolysis.

- *J. C. Lewis and H. S. Olcott. A lactobacillus assay method for 1(+)-glutamic acid. *Jour. Biol. Chem.* 157(1):265-285. Jan., 1945.

This paper presents a quantitative method for the determination of 1(+)-glutamic acid based upon its ability to stimulate growth of this organism, as measured by the production of lactic acid, in a medium containing the known requirements with the exception of 1(+)-glutamic acid. The techniques are based for the most part on those previously described for the microbiological determination of vitamins and amino acids by the use of *Lactobacillus arabinosus*.

- #B. Makower, S. M. Chastain, and E. Nielsen. Moisture determination in dehydrated vegetables. Vacuum oven method. *Indus. and Engin. Chem.* 38(7):725-731. July, 1946.

The loss of weight that occurs when dehydrated potatoes, carrots, cabbage, and onions are heated in a vacuum oven has been studied as a function of time, temperature, fineness of grinding of the sample, and degree of evacuation in the oven and the results are reported in this paper. The results were used for calibration of the vacuum oven method against a primary reference method for determination of moisture in the vegetables. The primary reference method consisted of drying to constant weight *in vacuo* over magnesium perchlorate at room temperature. Since this method was inconveniently slow, a more rapid, but equivalent, secondary method was also established. The conditions for the determination of water with an accuracy of ± 0.1 percent were as follows: Pressure, 5 mm. of mercury or less; fineness of sample, ground to pass a 40-mesh sieve; time of heating, carrots at 70° , 29 to 35 hours, potatoes at 70° , 43 to 67 hours, cabbage at 60° , 22 to 40 hours, and onions at 60° C., 15 to 45 hours.

- R. M. McCready, H. A. Swenson, and W. D. MacLay. Determination of uronic acids. *Indus. and Engin. Chem., Analyt. Ed.* 18(5):290-291. May, 1946.

The objective of the work reported here was to devise an effective procedure for determining the uronide content of pectic and other polyuronide substances in a appreciably shorter time than that required to carry out this type of analysis by currently recommended modifications of the Lefevre-Tollens method. Theoretical quantities of carbon dioxide were obtained for all uronic acids and their derivatives by heating the sample with 19 percent hydrochloric acid in an oil bath maintained at 145° C. for 1.5 to 2 hours. The apparatus is simple, compact, easy to construct, and offers a substantial saving of space and time. Analytical results on alginic acid were higher and more reproducible than those obtained by accepted methods.

- D. K. Mecham. The determination of cysteine and cystine by Vassel's method. *Jour. Biol. Chem.* 151(2):643-645. Dec., 1943.

Increased precision in the determinations of cysteine and cystine plus cystine, particularly in the presence of detergents, was obtained by modification of some details of Vassel's procedure.

- J. P. Nielsen and G. S. Bohart. Determination of crude lipid in vegetable matter. *Indus. and Engin. Chem.* 16(11):701-703. Nov., 1944.

Measurement of maturity in vegetables is of importance to the grower, processor and consumer. Maturity at harvest may affect yield of raw product, processing behavior, and quality and yield of final product. Many vegetables store starch, which can be measured as an index of maturity. Soybeans, however, do not store starch, and sweet corn presents analytical difficulties due to its glycogen content. These and other vegetables increase in lipid content as they mature and a simple method for the determination of crude lipid might serve as an index of maturity. This paper presents such a method. The complete procedure including preparation of the sample can be carried out in a relatively short time. The method yields considerably larger quantities of crude lipid from certain types of vegetable material such as immature seeds than do the commonly accepted procedures for crude fat. It is equally well adapted to wet or dry ground products.

- M. F. Pool and A. N. Prater. A modified Kreis test suitable for photocolormetry. *Oil and Soap* 22(9):215-216. Sept., 1945.

Because of its sensitivity and simplicity, the Kreis test is extensively used to detect oxidative deterioration in fats and oils. While the results are not a definitive index of rancidity, the information obtained is a highly useful supplement to other evidence. A sensitive form of the Kreis test for rancidity in fats

and oils is described in this paper. The reaction occurs in a one-phase system, which is suitable for direct photometric measurement. The procedure is convenient and rapid and yields reproducible results.

- A. N. Prater, E. J. Cowles, and R. P. Straka. Determination of ammonia by a diffusion method. *Indus. and Engin. Chem., Analyt. Ed.* 14(9):703-705. Sept., 1942.
Although several modifications of the diffusion cell technique have already appeared in the literature, it is believed that the one described in this paper is the simplest and most economical. To demonstrate its reliability, representative data are presented on the analysis of ammonium salt solutions, a meat extract, and a meat extract plus ammonium chloride solution. The data reported here were obtained by the electrometric method and checked carefully by the indicator method. The latter was found satisfactory and has the advantage of being faster but may be affected by personal error.
- *T. M. Shaw. A method of minimizing supercooling and its application in the determination of freezing points from dielectric constant measurements. *Rev. Sci. Instruments* 13(1):2-5. Jan., 1942.
The determination of the freezing points of water in colloidal systems from dielectric constant measurements is shown to be unsatisfactory when supercooling occurs. A method is described for minimizing supercooling, which makes possible accurate determinations of the freezing point. Data showing the freezing points obtained for a Barnes soil at various moisture contents are included.
- T. M. Shaw. The elimination of errors due to electrode polarization in measurement of the dielectric constants of electrolytes. *Jour. Chem. Physics.* 10(10):609-617. Oct., 1942.
Polarization of dielectric constant cell electrodes is an important source of error in determining dielectric properties of dilute electrolyte solutions. An investigation was made of the errors resulting from electrode polarization in measurements of the dielectric constants of solutions containing electrolytes. Applicability of two methods, one used by Fricke and Curtis and the other by Oncley, to eliminate these errors, was considered. There is introduced a modification of Oncley's method, which was found applicable at higher electrolyte concentrations than Oncley's method. Relative effectiveness of the modified method and that of Fricke and Curtis was tested by employing the two methods to correct experimental data obtained for aqueous solutions of glycine containing various amounts of electrolytes. Measurements were made at frequencies ranging from 10 to 5000 kc., and at conductivities ranging from 0.29×10^{-4} to 1.74×10^{-4} ohm⁻¹ cm⁻¹. Corrected values of the dielectric constant compared with known values in the literature were in good agreement. Limitations of the usefulness of the methods are discussed.
- *T. M. Shaw, A. R. Vorkoeper, and J. K. Dyche. Determination of surface area of dehydrated egg powder. *Food Res.* 11(3):187-194. May-June, 1946.
(See Studies on Eggs).
- L. M. White and G. E. Secor. Automatic cutoff for electrically heated water still. *Indus. and Engin. Chem., Analyt. Ed.* 18(5):332-333. May, 1946.
A working drawing and electric circuit diagram are shown for an automatic cutoff for an electrically heated water still equipped with the constant-level device described by Holmes (C.A. 34, 6489⁷).
- *L. M. White and G. E. Secor. Micro-Kjeldahl determination of nitrogen in gramicidin and tryptophan. Comparison of Gunning-Arnold-Dyer and Friedrich methods. *Indus. and Engin. Chem.* 18(7):457-458. July, 1946.
Work at this Laboratory on the modification of gramicidin through reaction with formaldehyde required a simple and reliable micromethod for the determination of nitrogen in this antibiotic and in certain of its derivatives and components. This

paper reports that mercuric oxide is a suitable catalyst for the microdetermination of nitrogen in tryptophan (indole and amino nitrogen) and its acetyl and benzoyl derivatives. By its use the recovery of nitrogen from the carbonyl compound is complete. With mercuric oxide as a catalyst, nitrogen may be determined in gramicidin and in the gramicidin-formaldehyde reaction product without the customary pretreatment with hydriodic acid.

Yeast:

- A. A. Klose and H. L. Fevold. Methionine deficiency in yeast protein. *Proc. Soc. Exp. Biol. and Med.* 56(2):98-101. 1944.

The present shortage of proteins has stimulated interest in the production of yeast for use primarily as a source of food (or feed) protein. Work now in progress in this Laboratory involves the development of methods to produce torula yeasts grown on molasses and fruit wastes, and the evaluation of these yeasts as a source of feed protein. This paper reports that brewer's yeast and torula yeast grown on molasses, when either was fed as the sole source of protein to growing rats, were found to be lacking in sufficient available methionine to produce growth equal to that elicited by an equivalent amount of casein. It appears that this fact is one limiting factor which must be considered in evaluating yeast protein as a replacement for animal proteins.

- A. A. Klose and H. L. Fevold. Nutritional value of yeast protein to the rat and chick. *Jour. Nutrition* 29(6):421-430. June, 1945.

Feeding experiments with rats as reported from this Laboratory have shown that yeast, when fed as the sole source of protein at levels as high as 13 percent crude protein, supplies an inadequate amount of methionine for optimum growth in the young rat. This work has been confirmed and extended in a series of rat and chick growth tests, the results of which are given here. Brewers' yeast, torula yeast grown on molasses, and a torula yeast grown on prune juice contained an inadequate amount of methionine for optimum rate of growth in a comparative study with relatively complete proteins. This inadequacy could be corrected by the addition of methionine or methionine-rich protein to the diet. Cystine corrected the deficiency to a limited extent. Yeasts at relatively high levels and over limited periods did not appear to be toxic.

- J. C. Lewis. Relationship of iron nutrition to the synthesis of vitamins by *Torulopsis utilis*. *Arch. Biochem.* 4(2):217-228. May, 1944.

In this Laboratory attention has been centered on the production of yeast high in vitamin content from the press juices of waste and cull fruits. Often growth factors on the vitamin B complex studied, the synthesis of nine by *Torulopsis utilis* is significantly affected by the iron nutrition of this yeast. Iron deficiency is accompanied by increased rates of synthesis per gram of yeast for thiamin, riboflavin, nicotinic acid, pyridoxin and pyridoxin isotels, and by decreased rates of synthesis for biotin, inositol, p-aminobenzoic acid, and Norit eluate factor isotels. It is concluded that studies of mineral nutrition offer considerable promise in a search for factors affecting the microbiological syntheses of vitamins.

- J. C. Lewis, J. J. Stubbs, and W. M. Noble. Vitamin synthesis by torula yeast. *Arch. Biochem.* 4(3):389-401, July, 1944.

Torulopsis utilis grown in high yields on fruit juice substrates was assayed for members of the B group of vitamins and the results are reported in this paper. The vitamin content was found to be roughly comparable to that of bakers' yeasts, and certain other microorganisms. When the high yields of *Torulopsis utilis* obtainable from cheap substrates are considered, it appears that this yeast is an outstanding vitamin producer. Significant amounts of a number of the vitamins are also found in the culture liquors.

J. J. Stubbs, W. M. Noble, and J. C. Lewis. Fruit juices yield food yeast. *Food Indus.* 16(9):694-696, 751. Sept., 1944.

Synthesis of protein through the growth of yeast on sugars and simple inorganic materials is of widespread interest at present. Yeast protein, which may make up half or more of the yeast dry substance, is regarded as having high nutritive value, and the yeast substance is an excellent source of B vitamins. These factors establish the value of yeast as a component of animal and poultry feeds and as a food supplement for man. The present paper shows that fruit waste materials furnish suitable media for torula yeast propagation. The technic developed for bakers' yeast can be used. Raw material is cheap and plentiful and the product has high nutritive value.

MISCELLANEOUS

- *C. H. Kunsman. Agricultural physics. *Amer. Phys. Teacher* 7:160-163. June, 1939.
This paper was one of four invited papers of a symposium on "The Physicist in Government Service," presented before the 8th Annual Meeting of the American Association of Physics Teachers, held in Washington, D. C., December, 1938. Examples of cooperative researches in which the physicist, physical chemist, mathematician and engineer participated were drawn from fertilizer, soil, agriculture and forest products, and meteorological investigations. Microscopic, X-ray, electron diffraction, calorimetric, spectroscopic, and spectrophotometric techniques are discussed.
- *T. L. Swenson. Agricultural chemical research for war and peace. *American Scientist* 32(3):196-204. July, 1944.
This paper presents a general discussion of the objectives of the Western Regional Research Laboratory, with examples given of several projects. Specific topics are "Research on Preservation of Foods," "Studies on Wastes and Byproducts," "Research on Non-food Products."
- T. L. Swenson. The Western Regional Research Laboratory--war program and Peace program. *Vortex* 5(8):334-337, 340-341. Oct., 1944.
This article presents a general statement regarding the change in emphasis that the war imposed on the research program of the Western Regional Research Laboratory and discusses agriculture's relation to industrial chemical research.
- *T. L. Swenson. Possible influence of technological developments on post-war dehydration and freezing of foods. Agriculture in transition from war to peace. (*Proc. Conf. West. Farm Econ. Assoc.*) pp. 156-164. June, 1944.
Recent advances in food dehydration and in food freezing are discussed in this paper and some probable trends in these industries are noted.
- *W. B. Van Arsdell. Wartime shortages challenge chemists and engineers. *Agr. Engin.* 23(3):86-87. 1942.
An analysis of the difficulties and dangers as well as the opportunities of wartime processing and distribution of farm products is herein reported.
- *W. B. Van Arsdell. The U.S.D.A.'s Western Regional Research Laboratory. *Pacific Pulp and Paper Industry*, pp. 33-34. Dec., 1944; *Paper Trade Jour.* 120(23):34-37. June, 1945.
This paper presents a general summary of the purpose, organization, and field of work of the regional research laboratories, and a brief description of major projects in the Western Laboratory, with special emphasis on those which have implications of interest to the pulp and paper industry.

Enzyme Research Laboratory, Western Regional Research Laboratory, Albany, Calif.
Information (mimeographed):

- 27 Separation of diastase and protein from wheat through the action of sulphites.
Sept., 1943.

Journal articles:

- A. K. Balls. A crystalline sulphur-protein from wheat. *Jour. Wash. Acad. Sci.* 32: 132-137. 1942.

An article summarizing the work to date on purothionin, the crystalline protein obtained by the Enzyme Laboratory from wheat. Its preparation and partial composition are given, and the reactions of this protein as part of an oxidation-reduction system are discussed. The effect of purothionin on the activity of crystalline chymopapain and on the oxidation of fats by lipoxidase from soybean is particularly stressed.

- A. K. Balls. Desmo Enzymes. *Vortex* 4(10):338-340, 342-344. 1943.

A summary of our work up to that time on the amylase of starch. This paper contains a description of the liberation of beta-amylase from wheat by sulphite solutions, and gives data which indicate that the enzyme exists in the flour as an inactive but activable "zymogen" protein. The properties of the zymogen are such that it comes very close to Willstätter's conception of a desmo enzyme. Possibly many desmo enzymes require chemical alteration (activation) as well as physical solution before they can be demonstrated.

- A. K. Balls. Control of enzymatic action in foods. *Proc. Inst. Food Technol.* pp. 165-169. 1943.

Besides a general discussion of the problem of enzyme action in foods, this paper gives a full account of our experiments on the inactivation of peroxidase by heat and its subsequent return to activity on standing. The matter was then important because the use of peroxidase tests for blanching was required by the Army, as well as because of the information on the composition and action of peroxidase that these experiments contributed. The work was continued in a paper by Schwimmer, *Jour. Biol. Chem.* 154, 361 (1944) q.v.

- A. K. Balls, H. Lineweaver, and R. R. Thompson. Crystalline papain. *Science* 86: 379. 1937.

Crystals showing strong proteolytic activity were isolated from the crude undried latex of the green papaya fruit. The crystalline material clots milk and digests casein. The material has an activity twice that of any commercial preparation. Further crystallization 4 to 5 times did not increase the activity of the materials. The crystals were obtained from the crude material by fractionation with ammonium sulphate.

- A. K. Balls and S. R. Hoover. The milk-clotting action of papain. *Jour. Biol. Chem.* 121:737-745. 1937.

A new method for the estimation of papain is given in detail, based on its property of clotting milk. The method is much simpler and quicker than any others proposed, even yet. The kinetics involved are also discussed. The paper recounts experiments on the mechanism of the activation of papain by phenylhydrazine in which it is shown that this reagent accelerates milk-clotting like hydrogen sulphide and cysteine. The milk-clotting property appears to be a function of the proteinase present not of the action of more or less hypothetical peptidases. Measurements of the temperature optimum of papain made by the new technique are given.

- *A. K. Balls and H. Lineweaver. Isolation and properties of crystalline papain. *Jour Biol. Chem.* 130:669-686. 1939.

This paper gives the methods for preparing crystals of a proteolytic protein from papaya latex. This protein was named papain by the authors. Two crystal habits are described, needles and six-sided plates. The molecular weight and some other analytical data on the protein are given. The ability of the pure protein to clot milk, hydrolyze proteins, and split hippurylamide (a peptidase-like function) is shown. Mixed crystals of active and inactive enzyme protein were also obtained.

- A. K. Balls and W. S. Hale. A sulphur-bearing constituent of the petroleum ether extract of wheat flour. *Cereal Chem.* 17:243-245. 1940.

Patent flour was extracted with petroleum ether, the extract concentrated and chilled and the insoluble material separated. The remaining extract was then mixed with three volumes of 1 N HCl in alcohol, whereupon a precipitate was formed. The precipitate was then washed with absolute alcohol and ether and dried *in vacuo*. This material was no longer soluble in petroleum ether, but was soluble in water and dilute alcohol. The water solution after reduction gave a powerful nitroprusside test. Analyses showed 13.4 percent total nitrogen, 3.9 percent protein nitrogen, 2.94 percent sulfur, and no phosphorous. Probably the extractable flour lipids contain a substance bearing a reversibly oxidizable SH group that could act as an activator for the flour proteinase.

- A. K. Balls and W. S. Hale. The effect of ethylene on freshly harvested Wheat. *Cereal Chem.* 17:490-494. 1940.

Freshly combined harvested wheat when treated with small concentrations of ethylene (1-10,000) showed marked improvement in its bread-making qualities. An immediate increase in the germinating ability of the wheat was noted after it was treated with a low concentration of ethylene, but there is evidence that higher concentrations cause a decidedly harmful effect. Results of these experiments show the possibility of using ethylene to hasten the well-known after-ripening process popularly designated as "sweating."

- A. K. Balls, R. R. Thompson, and W. W. Jones. Crude papain. *Indus. and Engin. Chem.* 32:1144-1147. 1940.

New sources of papain were investigated. The green fruit of the papaya appears to contain very little enzyme after the latex has been removed by tapping. The pressed juice from the leaves and stems of the papaya plant contain considerable papain. By acidifying and filtering this juice, it becomes stable and can be used as a source of enzyme preparations. Papain is precipitated by alcohol or ammonium sulphate. Both of these methods yield a product similar to commercial papain. Yield studies showed that from a ton of fresh plant material 12 pounds of papain could be recovered.

- A. K. Balls, H. Lineweaver, and S. Schwimmer. Drying of papaya latex--stability of papain. *Indus. and Engin. Chem.* 32:1277-1279. 1940.

Reasons for the instability of commercial papain have been sought. Deterioration is rapid during and after drying of the latex and is faster in air than in vacuum. Part of the inactivated enzyme is reactivated by cyanide. More activity is lost when the latex is diluted prior to use. The latex is shown to contain thermostable oxidation factor that destroys the enzyme. Methods for minimizing these losses are suggested. Stable enzyme preparations are obtained by adding salt to the latex and partially drying. Loss on dilution is minimized by diluting with boiled distilled water.

- A. K. Balls and F. E. Arana. Recent observations on the curing of vanilla beans in Puerto Rico. *Proc. 8th Amer. Sci. Cong.* 7:187-191. 1940.
Experiments on the respiration rate of green vanilla beans showed that the respiratory processes were faster immediately after injury to the tissue. Methods of curing vanilla intentionally produce such injuries, and may be useful in speeding up oxidation. The role of peroxidase in the chemistry of vanilla curin is discussed.
- A. K. Balls, R. R. Thompson, and M. W. Kies. Bromelin. Properties and commercial production. *Indus. and Engin. Chem.* 33:950-953. 1941.
The fate of bromelin, the proteolytic enzyme of pineapple juice, has been followed throughout the factory operations of pineapple canning. The enzyme appears in the juice and is there remarkably resistant to heat. A method is suggested which laboratory experiments (only) have indicated might be used to recover bromelin from low-grade juice without decreasing the yield of alcohol. The curious behavior of bromelin toward heating and alkali has been studied, and it was found that the activity of a bromelin preparation at a fixed pH depended upon the previous pH at which the preparation was held. The facts appear to be best explained by the assumption that the enzyme protein easily undergoes reversible denaturation.
- A. K. Balls and F. E. Arana. The curing of vanilla. *Indus. and Engin. Chem.* 33:107-1075. 1941; *Revista de Agricultura, Industria & Comercio de Puerto Rico* 34(20), 167-172. 1942.
The complete oxidation of aromatic substances during the curing of vanilla may lead to loss of aroma. On the theory that intermediate, not final, products of oxidation are desired, the beans were frozen. This reduces their CO₂ output during curing, and apparently allows enzymes of the peroxidase class an opportunity to store up intermediate oxidation products. The practical results of this modification of the curing process have been very satisfactory. See U. S. Patent #2,274,120 to Balls and Arana.
- A. K. Balls, W. S. Hale, and T. H. Harris. A crystalline-protein obtained from a lipoprotein of wheat flour. *Cereal Chem.* 19:279-299. 1942.
A crystalline protein-like material was prepared from the petroleum ether extract of patent flour. Analyses show that the principal amino acid residues are arginine and cystine. The crystals are the hydrochloride of a basic substance resembling the protamines. This hydrochloride has a minimum molecular weight of 6000 and a probable molecular weight of double that value. It therefore lies on a borderline between proteins and polypeptides. In the flour the material exists in the reduced form and is probably the activator of the wheat proteinase. It is thought that this protein-like material exists in the flour combined with a phosphorus-bearing lipid, and is therefore a component of one number of the little-understood class of lipoproteins.
- A. K. Balls, W. S. Hale, and T. H. Harris. Further observations on a crystalline wheat protein. *Cereal Chem.* 19:840-844. 1942.
A new crystalline protein isolated from patent flour is described. The crystals are the hydrochloride of a substance that appears to be related to the protamines. It is rich in arginine and cystine, and appears to be made up entirely of amino acid residues. Purothionin is suggested as a name for this protein material. Further information as to the construction of this protein was obtained by digestion with various crystalline and purified proteolytic enzymes. The extent of digestion was measured by the Van Slyke Apparatus. Evidence is given showing that at least one half of the nitrogen linkages in purothionin are the same as those occurring in proteins, and that the amino acids are linked in chains of 6 or 8 (probably 6).

- A. K. Balls, B. Axelrod, and M. W. Kies. Soybean lipoxidase. *Jour. Biol. Chem.* 149 (2):491-504. 1943.
Soybean lipoxidase, sometimes referred to as carotene oxidase, has been purified considerably. An extremely simple assay method based on the rate of oxidation of carotene in the presence of ethyl linoleate has been devised. Study of the purified enzyme led to the discovery of a heat-stable polypeptide material in soybean extracts which markedly enhances the catalytic effect of the enzyme. The activator appears to exert its effect by combining with the fat rather than with the enzyme. The inhibition of lipoxidase by purothionin, a polypeptide found in wheat, may also be caused by its effect on the fat emulsion. The substrate specificity of lipoxidase has been investigated with pure fatty acids. Linoleic, linolenic, and arachidonic acids were the only ones oxidized by the enzyme of a considerable number of acids tested. These acids are the so-called nutritionally essential fatty acids and it has been suggested that their function in the animal may be linked with a similar oxidative reaction.
- A. K. Balls and I. W. Tucker. Extraction of diastase and recovery of protein from wheat. *Fruit Prod. Jour.* 23(1):15. 1943.
A description of the activation and solution of beta-amylase from wheat flour by dilute sulphite solutions, and the further use of the otherwise wasted wheat enzyme to fortify malt in the ordinary conversion process. During the extraction much of the gluten present forms a clot that may be easily removed and dried.
- A. K. Balls and T. H. Harris. Inhibitory effect of a protamine from wheat flour on the fermentation of wheat mashes. *Cereal Chem.* 21(1):74-79. 1944.
At the commencement of the war, production of alcohol from wheat became desirable, but unexpected technical difficulties were encountered. This paper presents evidence for the existence of a fermentation inhibitor in wheat flour, and shows how it may be inactivated or destroyed.
- A. K. Balls and S. Schwimmer. Digestion of raw starch. *Jour. Biol. Chem.* 156(1):203. 1944.
Uncooked starch granules may readily be broken down (as observed microscopically) and digested to maltose and glucose by a mixture of hog pancreas and *Aspergillus oryzae*. A necessary inorganic factor in the ash of wheat flour was found to be calcium. The pH and temperature optima are 5.2 and 55° C., respectively. Different starches vary in the readiness with which they are broken down. Potato starch is relatively resistant compared to corn and wheat starches. The size of the starch granule does not seem to be a determining factor in this resistance.
- *A. K. Balls, R. R. Thompson, and M. K. Walden. A crystalline protein with beta-amylase activity, prepared from sweetpotatoes. *Jour. Biol. Chem.* 163, No. 2, May, 1946.
Preparation of crystalline beta-amylase from sweetpotatoes is given, together with data characterizing the substance as a protein.
- E. J. Coulson, T. H. Harris, and B. Axelrod. Effect on small laboratory animals of the injection of the crystalline hydrochloride of a sulphur protein from wheat flour. *Cereal Chem.* 19:301-307. 1942.
A crystalline sulphhydryl compound of protein-like nature (purothionin) obtained from wheat was investigated pharmacologically. The LD₅₀ for guinea pigs on intravenous injection was approximately 1.6 mg./kilo. The LD₅₀ by the intraperitoneal route for mice was of the same order of magnitude as for rabbits, i.e., 12-15 mg./kilo. Rabbits were barely affected by 13.8 mg./kilo. On intravenous injection the LD₅₀ for guinea pigs was 1.6 mg./kilo. Rabbits appeared to be somewhat more resistant. Guinea pigs tolerated the oral administration of 50-100 lethal

intravenous doses. Five-hour acid hydrolysis greatly reduced the toxicity of the compound, judging by the effects of intraperitoneal injection into mice. Concentration of the protein as low as 1 part in 1,250,000 caused the contraction of the isolated guinea pig uterine strip. The response to this substance, unlike histamine, depended upon the presence of calcium ion within very narrow limits of concentration. Acid hydrolysis of the protein completely destroyed its uterus contracting property.

- G. Y. Gottschall. The activation of papain during digestion of meat. *Food Res.* 9: 6-10. 1944.

Partially inactive papain becomes more active during the digestion of some proteins, but not of others. The progressive activation was shown to be due to the reducing action of sulphydryl groups uncovered during the proteolysis. The initial degree of activation required for papain digestion thus depends upon the nature of the substrate.

- W. S. Hale. The proteinase in wheat flour. *Cereal Chem.* 16:695-702. 1939.

A proteinase was extracted from patent flour with 10 percent sodium chloride solution. This extract was purified by fractional precipitation with ammonium sulphate. The enzyme was purified further by dialysis to remove the ammonium sulfate. A reference preparation was then made for comparison with proteinases previously prepared from wheat bran and whole wheat. Examination of its behavior toward oxidizing agents and reducing agents led to the conclusion that it is an enzyme of the papain type. This flour proteinase was found to be activated by cysteine and inactivated by iodoacetic acid and a variety of bread improvers. There was no evidence that this proteinase from patent flour is different from that extracted from wheat bran or whole wheat flour.

- *W. S. Hale, S. Schwimmer, and E. G. Bayfield. Studies on treating wheat with ethylene. I. Effect upon high-moisture wheat. *Cereal Chem.* 20(2):224-233. 1943.

The application of ethylene gas in the proportion of 1 part of ethylene to 100,000 parts of air to freshly harvested, high-moisture wheat in semi-commercial bins increased the respiration. The treated wheat did not heat as rapidly or as much as the untreated. The grade of the grain, percentage germination, and baking performance of the treated samples were superior to the untreated during several months of storage. The experiments indicate that ethylene gas does not prevent spoilage of high-moisture wheat on storage, but the heating of such wheat may be materially retarded, possibly because of an artificial ripening of the greener kernels present.

- #M. W. Kies and S. Schwimmer. Observations on proteinase in brain. *Jour. Biol. Chem.* 145:685. 1942.

Brain proteinase has been partially purified and shown to be of the catheptic type. Di- and tripeptidases were found to be present in brain tissue. No evidence was obtained for the presence of a lipolytic enzyme similar to the one previously reported in muscle. The results indicate the presence of a surprisingly large amount of cathepsin in brain as compared with muscle. Brain, however, autolyzes neither more rapidly nor to a greater extent than muscle under similar conditions. While the effect of the brain cathepsin undoubtedly contributes to the difficulty of handling brain tissue commercially, it does not seem to afford adequate explanation of the rapid disintegration of the material that is so frequently observed in the packing industry.

- H. Lineweaver and S. R. Hoover. A comparison of the action of crystalline papain on native and urea denatured proteins. *Jour. Biol. Chem.* 137:325-335, 1941. Data indicate that papain is probably able to attack certain native proteins, although slowly. The increased rate of digestion shown by denatured proteins parallels the increase in the chemical reactivity of certain groups, namely, S-S, -SH, and phenolic OH. These results appear to be unaltered by the mode of denaturation employed.
- S. Schwimmer. Comparison of crude and purified preparations of a leucyl-peptidase associated with beef muscle. *Jour. Biol. Chem.* 154(2):361, 1944. A highly active specific enzyme capable of hydrolyzing leucylglycine and leucyl diglycine but not simple glycine or alanine peptides, has been found associated with beef tissue. Its properties have been compared with a crude glycerol extract of beef muscle. The properties investigated (pH vs. activity, specificity, activation by manganese, stability) indicate that the purified enzyme is a leucyl-peptidase, whereas the starting material contained more than one peptide-splitting enzyme.
- S. Schwimmer. Regeneration of heat inactivated peroxidase. *Jour. Biol. Chem.* 154(2):487, 1944. The regeneration as a function of time and temperature was studied. It was found that regeneration is largely a function of the heating rate, has a positive temperature coefficient, and is a time reaction. Factors that are essential for regeneration exist in both the precipitate formed upon heating and in the supernatant therefrom. Evidence is given to show that vegetables may contain more than one peroxidase, and that these enzymes vary in their activities toward iodide and pyrogallol, respectively. A vegetable may be characterized by comparing the iodide and pyrogallol oxidizing activities. The precipitate formed when vegetable juice is heated carries these characteristic properties of the peroxidase with it. Reappearance of the enzyme after heat treatment involves resolution of this insoluble component, recombination with a soluble group, which may well be the same for the vegetables studied, and reversion of enzyme protein to its native state.
- S. Schwimmer. The role of maltase in the enzymolysis of raw starch. *Jour. Biol. Chem.* 161(1):219, Nov., 1945. The enzymolysis of raw starch by mixtures of *Aspergillus oryzae* and pancreatic amylase has been studied in detail and compared with their action on cooked starch. The complementary action has been traced to the maltase of the *Aspergillus*. The observations made have been interpreted to mean that the maltase decreases the operation of the following factors which tend to present complete conversion by the alpha-amylase; irreversible inactivation; reversible inhibition by maltose, resynthesis from maltose; slow rate of hydrolysis of the "abnormal" linkages present in amylopectin. These interfering factors can be equally minimized in the absence of maltase by concomitant dialysis of the amylase-starch reaction mixture. Consequently, raw starch can be completely digested by pancreatic amylase alone in a dialysis apparatus. Whereas the difference in the action of alpha-amylase on raw and cooked starch seems to be one of rate imposed upon the system by limited substrate available, the complete lack of susceptibility of the starch granule to attack by beta-amylase has been attributed to the masking (by strong hydrogen bonding) of the non-reducing end of the glucose chains.

- L. S. Stuart and T. H. Harris. Bactericidal and fungicidal properties of a crystalline protein isolated from unbleached wheat flour. *Cereal Chem.* 19:288-300. 1942.
- Crystalline purothionin, obtained from wheat flour, was found to be antibiotic against certain bacteria and fungi, particularly saprophytic types. The potency of purothionin as a "germicide" is considerable, but the substance is also quite toxic. See Coulson, Harris, and Axelrod, *Cereal Chem.* 19:301, 1942.
- *I. W. Tucker. Effect of flour lipids on recovery of gluten from hard and soft wheat flours by the use of sulfite solutions. *Cereal Chem.* 23:2. 1946.
- The recovery of gluten from flour by coagulating it with sulphite solutions (apparently due to activation of a proteolytic enzyme) is fairly complete with the high-protein (hard wheat) flour but very small with low-protein (soft wheat) flour. If the lipids are extracted from soft wheat, results approaching those with hard-wheat flours are obtained. Conversely, if flour lipids are added to hard-wheat flour, the recovery of gluten is low, as with soft-wheat flour. Apparently the ratio of protein to lipid determines the ease of coagulation of the gluten, and a mechanical explanation is suggested, based on the assumption that a heavy film of fat on the surface of a gluten particle prevents its coalescence with other coated particles, and thus prevents the formation of a clot.

Pharmacological Laboratory, Western Regional Research Laboratory, Albany, Calif.
(Recent publications.)

- A. M. Ambrose and F. DeEds. Acute and subacute toxicity of pure citrinin. *Proc. Soc. Expt. Biol. and Med.* 59(2):289-291. June, 1945.
- Citrinin is an antibiotic produced by *Penicillium citrinum*, and by *Aspergillus sp.* of the *candidus* group. The lower toxicity values reported by Robinson, as compared with those reported by Limonin and Rouatt and those reported here, may be due to a low rate of absorption of citrinin from a suspension in gum acaci solution. Citrinin in solution is rapidly absorbed, regardless of the mode of administration, as shown by the toxicity data. The production of tissue changes and the fact that citrinin may result in delayed deaths, up to fourteen days, would make a statement regarding an LD₅₀ dose misleading.
- A. M. Ambrose and F. DeEds. Norelac--A substitute for shellac in the preservation of smoked paper records. *Science* 102(2642):179-180. Aug. 1945.
- This paper reports that Norelac, a thermoplastic polymer developed at the Northern Regional Research Laboratory, can be substituted for shellac with complete satisfaction. A 5-percent solution of Norelac in a mixture of isopropyl alcohol and Skelly Solvent "C" (or naphtha) makes a good protective coating for a smoked-paper record. The record dries in ten minutes with a dull finish. If less than 5 percent of Norelac is used, abrasion marks are easily produced. If 10 percent of Norelac in isopropyl alcohol and Skelly Solvent "C" is used, the record dries free from tack in ten minutes with a glossy finish.
- *F. DeEds. Protein-ascorbic acid complex in carrots. *Food Res.* 8(4):275-279. 1943.
- This paper reports that carrots, like certain other vegetables, contain protein-combined ascorbic acid. Since ascorbic acid in this form is biologically available, it must be taken into consideration in determining the vitamin C value of different foods and in comparing the bioassay and chemical methods. The degree of protection which such a combination may afford ascorbic acid during dehydration and processing of food is worthy of investigation.

- F. DeEds. The toxicity of fluorine in dicalcium phosphate. *Amer. Jour. Med. Sci.*, 203(5):678-692., May, 1942.

Dicalcium phosphate is used as a dietary supplement during pregnancy, and for infants and children. Since fluorine is present in dicalcium phosphate as an impurity due to the sources of raw material or methods of manufacture, obstetricians and pediatricians should give consideration to the possibility of chronic fluorine poisoning. This paper reports a study of the toxicity of fluorine present in dicalcium phosphate, using the bleaching of rat incisor teeth as a criterion of injurious action. The fluorine present in dicalcium phosphate has been shown to be as physiologically active as fluorine administered as sodium fluoride. An average daily dose of 1 teaspoonful of dicalcium phosphate containing 0.27 percent fluorine represents a fluorine intake 10 times as great as the amount said to produce mottled enamel in at least some children.

- *F. DeEds and J. O. Thomas. Studies on phenothiazine. IX. The biliary excretion and anthelmintic action of thionol. *Jour. Parasitology* 27(2):143-151. April, 1941. Phenothiazine is one of the most effective, and certainly the most versatile, of the organic compounds developed by the U. S. Department of Agriculture. In addition to being a promising insecticide, phenothiazine has been shown to be useful as a urinary antiseptic, and is now receiving considerable attention as an anthelmintic for removal of parasites from farm animals, notably sheep. The demonstration that thionol, an oxidation product of phenothiazine, is excreted in the bile may be important to our understanding of the anthelmintic action of phenothiazine.

- *F. DeEds. Studies of phenothiazine. X. Further observations on oxidation of phenothiazine. *Prox. Soc. Expt. Biol. and Med.* 45:632-634. 1940.

Developments on the use of phenothiazine as a fungicide pointed to the importance of the observation that in the dry state phenothiazine oxidizes, a response which having been repeatedly confirmed, was deemed worthy of a report. The experiments reported here suggest that the distribution of phenothiazine over the extensive surface presented by bentonite permits intimate contact with atmospheric oxygen, thereby facilitating oxidation, an action which may be further aided by the alkalinity of the hydrated lime.

- F. DeEds and J. O. Thomas. Studies on phenothiazine. XI. The excretion of phenothiazine. *Jour. Parasitol.* 28(5):363-367. Oct., 1942.

Evidence is presented in this paper to show that the reversible oxidation-reduction system phenothiazine-leucophenothiazine, as well as thionol-leucothionol, occurs in the urines of rats, rabbits, and humans receiving phenothiazine. The validity of potentiometric measurements for the identification of a reversible oxidation-reduction system is discussed. The melting point of leucophenothiazine was shown to be 172-173° C. Samples of leucophenothiazine isolated from rat, rabbit, and human urines were identified by their melting points, namely, 172-173° C. and by their mixed melting points with synthetic leucophenothiazine. Leucothionol oxidizes so rapidly that it is impracticable to obtain its melting point. It is suggested that a compound isolated from the urine of a phenothiazine-dosed sheep by another worker was leucophenothiazine and not phenothiazine.

- R. H. Wilson, J. O. Thomas, and F. DeEds. Vitamin A value of fresh and dehydrated carrots. *Fruit Prod. Jour.* 22(1):15-17. Sept., 1942.

This paper is concerned with the vitamin A value of fresh and dehydrated carrots of the Chantanay variety. The parallelism between the chemical and the biological methods for evaluating vitamin A both before and after a processing technique is studied.

- #R. H. Wilson, A. M. Ambrose, F. DeEds, H. J. Dutton, and G. F. Bailey. The content and biological availability of carotene in raw and dehydrated carrots and other vegetables. *Arch. Biochem.* 10(1):131-140. May, 1946.
(See Carotene).

Laboratory of Fruit and Vegetable Chemistry 148 South Mission Road, Los Angeles 33, Calif. (Only recent publications of this Laboratory are included here or elsewhere in this list. A complete list can be obtained from the address given above.)

- E. A. Beavens. Cabinet dehydrators suited to small-scale operations. *Food Indus.* 1. 16(1):70-72, 116; 11. 16(2):90-92, 134; 888. 16(3):75, 135-136. Jan.-Mar., 1944. (See Dehydration.)
- *E. A. Beavens. Food dehydration--a revived industry. *Rural New Yorker.* Jan., 1943. This article is a general discussion of the food dehydration industry, including some of the historical background and efforts made to improve the methods of processing during World War II. The importance of dehydration under war conditions is indicated, as well as the peace-time possibilities for the industry.
- *E. A. Beavens. Advances in methods of food dehydration. *Rural New Yorker.* April, 1943. This article discusses the varieties of vegetables best suited for dehydration, as well as the effects of growing conditions and harvesting on the quality of the finished product. The various processing methods used in dehydration are described, including preparation, steam blanching, cabinet dryinv versus tunnel drying, equalizing, and packaging.
- E. A. Beavens and J. A. Bourne. Commercial sulfiting practices. *Food Indus.* 17(9) 100-101. Sept., 1945.
(See Dehydration.)
- E. M. Chace. The present status of food dehydration in the United States. *Proc. Inst. Food Technol.* pp. 70-89. 1942.
(See Dehydration.)
- M. E. Davis, E. M. Chace, and C. G. Church. Protein and sulfur content of immature lima beans as affected by varietal and environmental factors and processing. *Food Res.* 7(1):26-37. 1942. The data presented herein are part of the results of studies made as a joint research by the U. S. Department of Agriculture and the University of California. The report is concerned with the protein and sulfur contents of green lima beans as affected by hereditary and environmental factors. It is concluded that environment and water balance, rather than heredity, determine the levels at which nitrogen and sulfur occur in immature, green lima beans. There is slight change in the nitrogen and sulfur fractions of the total solids because of removal of white, immature beans or because of blanching, freezing, and drying processes.
- W. B. Davis. Distribution and preparation of citrus peroxidase. *Amer. Jour. Bot.* 29(3):252-254. March, 1942. This paper was written to prove the existence, and point out the distribution of peroxidase in some citrus fruits and to describe some of the attempts to make a crude preparation of this enzyme. The distribution of peroxidase in different tissues of orange, grapefruit, lemon, and tangerine is shown, and the high activity in the inner seed coat of these fruits, especially tangerines, is pointed out. Hand-removed seed coats gave the highest activity in crude preparations. That it may be possible to make peroxidase on a large scale is indicated from experiments with lemon seeds, which are available in quantity.

- *W. B. Davis. Quantitative field test for estimation of peroxidase. *Indus. and Engin. Chem., Analyt. Ed.* 14(12):952-953. Dec., 1942.
Blanching, considered an essential operation in the dehydration of many vegetables, inactivates enzymes that might otherwise cause deterioration of the product. Attempts have been made to define the heating which a product has undergone by observing the extent to which certain easily measured enzymes have been destroyed thereby. The method described in this paper appears to meet the requirements for a simple, swift test for the blanching of vegetables. It is particularly applicable to control of the blanching time of cabbage. The test may be used in other fields, such as blanching before quick-freezing.
- *C. W. Eddy. Absorption rate of oxygen by orange juice. *Indus. and Engin. Chem.* 28(4):480. Apr., 1936.
The diminution in the reducing factor of California Valencia orange juice in the presence of oxygen alone; oxygen plus 20 parts per million of cupric ion, of zinc ion, and of stannous ion; and of oxygen with an added ascorbic acid preparation, was determined. Data are given to correlate the disappearance of reducing substances with the absorption of oxygen. A comparison between the disappearance of the reducing substances and the rate of oxygen absorption indicates the close relationship and reaction between ascorbic acid and oxygen.
- H. J. Loeffler. Determination of air in citrus juices. *Indus. and Engin. Chem. Anal. Ed.* 12(9):533-534. Sept., 1940.
During the course of an investigation on (bottled citrus juices) or (the bottling of citrus juices), it was necessary to measure the degree of deaeration of the juices prior to pasteurization. This paper presents the means used to measure the degree of deaeration and discusses the efficiency of the deaerator. An inverted dome type of deaerator was used. In most cases, only the total air content was determined. The results show that sufficient deaeration is rarely obtained by a single passage through the deaerator; two or three passages are essential. The efficiency of air removal appears dependent also on the rate of passage through the deaerator. The few differential analyses included indicate that carbon dioxide is present in comparatively large quantities in the fresh juice, apparently arising from respiration in the oranges themselves rather than from incorporation during the reaming and screening.
- *H. J. Loeffler. Processing of orange juice. *Indus. and Engin. Chem.* 33(10):1308-1314. Oct., 1941.
This paper recommends high-temperature pasteurization to retain the "cloud" in orange juice and rapid cooling to avoid cooked flavors that such temperatures are likely to develop. Quantitative methods using a photoelectric colorimeter have been devised for measuring vitamin C, color, cloud, and amino nitrogen content. These tests indicate that during warm storage of pasteurized orange juice, carbon dioxide is produced, the color darkens, vitamin C is lost, the "cloud" settles (unless a sufficiently high pasteurization temperature has been used), and off-flavors develop. These changes are prevented by cool storage. Appreciable vitamin C may be lost from frozen juice stored at 0° F. (-18°C.) in the presence of air.
- *H. J. Loeffler. Maintenance of cloud in citrus juices. *Proc. Inst. Food Technol.*, pp. 29-36. 1941.
This study of quantitative "cloud index" values, determined with a photoelectric colorimeter on experimental packs of citrus juices, reveals that the "cloud" is actually increased by flash-pasteurization and not merely stabilized thereby. The enzymic changes occur so rapidly after the reaming of the fruit that at least a partial enzymic coagulation of the cloud will occur before the juice can be

screened, deaerated, and heated to a pasteurization temperature. The loss of cloud during storage after processing is not due entirely to pectic enzymes, since heavily clouded samples pasteurized at a comparatively high temperature still lose an appreciable portion of their cloud. Homogenization before pasteurization not only increases the cloud but actually forms a stable suspension of the pigmented material in the supernatant liquid. In this way, the unsightly separation in bottled orange juice is masked and a highly appealing product is produced.

- D. G. Sorber. The relation of the sulfur dioxide and total sulfur contents of dried apricots to color change during storage. *Fruit Prod. Jour. and Amer. Food Mfr.* 23(18):234-237, 251, Apr., 1944.
(See Dehydration).

Fruit and Vegetable Byproducts Laboratory, College Station, Box 8, Pullman, Washington. (Cooperative with Washington Agricultural Experiment Station).

- *C. W. Eddy and M. K. Veldhuis. New nectar made from fresh prunes. *Food Indus.* 14(13):46-47, March, 1942.

This paper reports that fresh Italian prunes have been used in the preparation of a new product--prune nectar, which is rich in color and of pleasing taste and aroma. The product offers excellent opportunities as an outlet for culls.

- *D. R. McCormick, M. K. Veldhuis, and J. L. St. John. Variations in acidity of Concord grape juice. *Fruit Prod. Jour. and Amer. Food Mfr.* 24(4):101-102, 125, Dec., 1944.

Considerable variation in the acidity of Concord grape juice on the market has been observed, and the main purpose of the investigation reported here was to obtain information on the variations of malic and free tartaric acids in juices obtained from several of the principal producing sections of the country. Whereas the cream of tartar content can be controlled to a certain extent by the processor, the malic and free tartaric acids can not. It was found that the content of free tartaric acid varied from none to 0.26 gram per 100 ml. and that of malic acid from 0.22 to 0.44 gram per 100 ml.

- A. M. Neubert. Effect of filtration on appearance, viscosity, and alcohol-insoluble fractions of apple juice. *Food Res.* 8(6):477-488, Nov.-Dec., 1943.

The effect of filtration on appearance, viscosity, and alcohol-precipitate and pectic-acid fractions of apple juice is reported in this paper. Raw unheated juice, flash-heated and cooled juice, and juices clarified by enzyme treatment and by gelatin-tannin fining were investigated. Seven grades of Seitz filter sheets and Whatman No. 2 filter paper were used as filtering mediums. Changes caused by filtration were compared with those caused by centrifuging juice.

- *A. M. Neubert. The effect of concentration on the composition and properties of rediluted apple juice. *Fruit Prod. Jour. and Amer. Food Mfr.* 23(6):166-169, Feb., 1944.

The results presented in this paper indicate that with certain precautions apple juice can be concentrated, either by vacuum distillation or by freezing, and rediluted without seriously affecting its chemical composition. Ordinary vacuum distillation results in a loss in aroma, but methods of recovering these volatile fractions have been developed which reduce this loss. Because detection of aroma is dependent on the variable human factor, its value in identifying rediluted products is limited in any case. Changes in viscosity, alcohol precipitate, and pectic acid were considered to be of no value in detecting products prepared from concentrates, because differences between fresh and reconstituted juice were smaller than the normal variations found among fresh and preserved apple juices. Other properties of apple juice commonly determined in ascertaining adulteration were not noticeably altered by concentration.

- *A. M. Neubert, M. K. Veldhuis, and W. J. Clore. The effect of harvest maturity on the canning quality of Western-grown Elberta peaches. *Fruit Prod., Jour. and Amer. Food Mfr.* 23(10):292-297, 315, 317. June, 1944.

The quality of canned soft-ripe freestone peaches is markedly affected by the maturity of the fruit when harvested. The effect of harvest maturity on the canning quality of Elberta peaches grown in Washington are described in this paper, and data on size, color, firmness, time required to ripen, wilting losses, yield of cans, and quality of the canned fruit are presented. With all factors taken into consideration, the most satisfactory harvest maturity for Elberta peaches, as grown in the Pacific Northwest, was found when the fruit was about 75 percent yellow (No. 4 or slightly more yellow according to the apple color chart, Magnes Diehl, and others, 1926), and gave an average pressure test on peeled fruit of from approximately 4 pounds with a 7/16-inch plunger to approximately 9 pounds with a 5/16-inch plunger. Such fruit required from 3 to 7 days to ripen for canning. Color-picking, involving 2 or more harvests, would appear necessary to attain this maturity throughout a harvest.

- *A. M. Neubert and M. K. Veldhuis. Research shows effects of maturity and storage on canned Pacific NW freestones. *West. Canner and Packer* 36(9):23, 53, 55. Aug. 1944. Investigations were made on the suitability of varieties for canning and the effects of harvest maturity, ripening procedure, and storage on the canning quality of the fruit. A summary of the results of these investigations are presented in this paper. Elberta, Early Elberta, and Gold Medal were considered the best canning varieties of those studied. The best-quality canned Elberta peaches were obtained from fruits harvested when the ground color was about 75 percent yellow and the firmness ranged from four pounds with a 7/16-inch plunger to eight pounds with a 5/16-inch plunger. Elberta peaches ripened at 75° F. over a wide range of humidity consistently yielded a canned product of good quality. Low-temperature storage did not improve the canning quality of Elberta peaches, but when ripe fruit was stored at 31° F., an acceptable product was obtained after as long as 4 weeks' storage.

- *A. M. Neubert and M. K. Veldhuis. Ripening Washington-grown Elberta peaches for canning. *Fruit Prod., Jour., and Amer. Food Mfr.* 23(12):357-360, 379, 381. Aug., 1944. Studies were conducted on the effect of several ripening procedures on the canning quality of Washington-grown Elberta peaches. Special attention was given to influence of temperature and humidity during ripening on (1) the rate of ripening, (2) wilting during ripening, (3) peeling and pitting characteristics, and (4) the color, flavor, and texture of the canned product. The rate of ripening after harvest was accelerated by increasing the temperature. The characteristic color of canned peaches became progressively deeper yellow as the ripening temperature and humidity increased, but high temperatures, particularly under conditions of high humidity, should be avoided if the best flavor and peeling characteristics are to be obtained. The most satisfactory ripening temperature, considering all factors, was 75° F.

- *A. M. Neubert and M. K. Veldhuis. Clouding and sedimentation in clarified apple juice. *Fruit Prod., Jour., and Amer. Food Mfr.* 23(11):324-328. July, 1944.

The phenomena of clouding and sedimentation in clarified apple juice and methods for its control were investigated and a chemical study of the sediment was made. No dependable method for controlling or delaying sedimentation was found and its formation appeared to be quite general during storage of pasteurized, clarified apple juice regardless of the variety or maturity of the apples used or methods used to attain clarification. Juice clarified by means of pectin-decomposing enzymes in general deposited a greater amount of sediment and after a shorter storage period than did other methods of clarification. Juices varied widely in storage period required before sedimentation occurred, in some cases remaining clear

for over two years, which may account for the discrepancies in the literature regarding methods of preventing its formation. Sediment obtained from apple juice was tentatively identified as a photophene.

- *A. M. Neubert and M. K. Veldhuis. Cleaning vined canning peas by froth flotation. *Food Indus.* 17(5):494-497, 608, 610, 612, 614, 616. May, 1945.
- This process removes troublesome foreign materials, thus saving labor on inspection line. Air bubbles can be attached selectively to materials to float them off. The principles of the process might be applied in other fields. As reported in this paper, the process involves the use of an oil-in-water emulsion into which air is incorporated as small bubbles. A foaming agent is used to maintain the stability of the foam and to aid in emulsifying the oil. Density of the mixture in the separation unit varies with the amount of separation of foam. At no point does it appreciably exceed that of water, and in certain parts of the mixture it is well below 0.7. Details of equipment design, reagents, and operation are given.
- *M. K. Veldhuis and A. M. Neubert. Freestone peach varieties for canning in Washington. *Fruit Prod. Jour. and Amer. Food Mfr.* 23(9):229-233. Apr., 1944.
- Of 46 varieties reported in this study the Elberta, Gold Medal, and Early Elberta are the most desirable for canning when all points are considered. These varieties, however, do not meet all of the requirements desired in freestone peaches intended for canning, because they occasionally exhibit semi-cling pits. A number of other varieties are suggested for canning purposes to permit a lengthening of the canning season, even though they require special attention in harvesting to assure a satisfactory texture. Among these are Shalil, Golden Jubilee, July Elberta, Valiant, Mowery, South Haven, and Hale Haven. A soft fibrous texture when canned is the most frequently encountered defect in freestone peach varieties, although clinging pits and discoloration in the can make several undesirable. The J. H. Hale, Rio-Oso-Gen, and Candoka are among those that occasionally discolor severely in the can.
- M. K. Veldhuis and A. M. Neubert. The effect of storage on the canning quality of Elberta peaches. *Fruit Prod. Jour. and Amer. Food Mfr.* 23(9):276-281. May, 1944.
- The effect of storage at 31°, 37°, and 45° F on the canning qualities of Elberta peaches was studied. Data show that storage did not improve the canning qualities but under the proper conditions the fruit could be held up to 3 or 4 weeks, and still be acceptable. If the storage of Elberta peaches for canning is necessary, it is suggested that the temperature be as near 31° F. as possible without danger of freezing and that the maturity of the fruit be within 5 days of full canning ripeness. If the fruit is not at this maturity when received, it appears desirable to allow it to ripen before storage. The storage period should not be longer than necessary and should not exceed 4 weeks. Badly bruised fruit should not be stored.
- M. K. Veldhuis and A. M. Neubert. Cleaning vined canning peas by froth flotation, removal of nightshade. *West. Canner and Packer* 36(6):19, 47. May, 1944.
- This paper is a preliminary report of studies on a new process for removing nightshade berries, tarweed seed, and other foreign material from vined green peas. The process involves froth flotation and makes use of small air bubbles to float away the undesirable material. Successful pilot plant tests were made

#A. M. Neubert and G. H. Carter. Factors influencing color of canned freestone peaches. *West. Canner and Packer* 38(11):56-59, Oct., 1946.

A study of the influence of processing methods on the color of canned freestone peaches is herein reported. Methods of delaying discoloration from oxidation before cooking and of reducing this discoloration by processing were studied. Methods of improving the color of canned peaches through control of the exhaust and sealing procedures were investigated. Discoloration from oxidation after peeling was effectively retarded by increasing to 90 seconds the steaming time used to loosen the skins. Similar results were obtained by immersing the peeled fruit for one minute in either a 2-percent solution of citric acid, a 2-percent solution of sodium chloride, or a 0.5-percent solution of hydrochloric acid. Chemical dips were not considered necessary, however, if a sufficiently long steaming time was used to loosen the skins. Discoloration already present was reduced to a minimum in the canned product by decreasing the oxygen in the container at the time of sealing and also by increasing the time of steam exhaust. The value of extending the steam exhaust time as much as possible, consistent with practical can vacuum, was demonstrated as a means of removing chalky areas in the flesh and thereby improving the color of canned peaches. Sealing cans with a minimum of entrapped atmospheric oxygen proved desirable in preventing darkening of peaches, in obtaining a clearer sirup, and in hastening the disappearance of red color in the sirup.

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- *A. K. Balls and W. S. Hale. Method of treating cereal grains. U. S. Patent 2,381,421. August 7, 1945.
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- 8. K. J. Miller, U. S. Pat. 2,415,007, May 19, 1948.
- 9. K. J. Miller, U. S. Pat. 2,415,008, May 19, 1948.
- 10. K. J. Miller, U. S. Pat. 2,415,009, May 19, 1948.